

Canada, National Committee

CAI
L9
-56A55

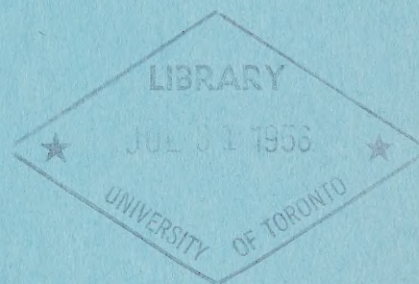
Can
Com
M

The Machinist's Trade
General publication 26-17

AN ANALYSIS

OF THE

MACHINIST'S TRADE



PREPARED BY

A NATIONAL COMMITTEE

APPOINTED BY

THE DEPARTMENT OF LABOUR

OTTAWA, CANADA

1956



3 1761 11766640 4

AN ANALYSIS OF THE MACHINIST'S TRADE



IN THE FOLLOWING PAGES IS SET FORTH THE ESSENTIAL
BODY OF KNOWLEDGE AND SKILLS TO BE MASTERED BY
A TRAINEE DURING HIS APPRENTICESHIP IN THIS TRADE.

IT IS SUGGESTED THAT ALL USERS OF THIS MATERIAL
READ THE INTRODUCTION IN DETAIL SO AS TO BE FULLY
ACQUAINTED WITH THE BACKGROUND AND OBJECTIVES
OF THE ANALYSIS.


PREPARED BY

A NATIONAL COMMITTEE

APPOINTED BY

THE DEPARTMENT OF LABOUR
OTTAWA, CANADA

1956



Digitized by the Internet Archive
in 2022 with funding from
University of Toronto

<https://archive.org/details/31761117666404>

AN ANALYSIS OF THE MACHINIST'S TRADE

TABLE OF CONTENTS

	Page
A. INTRODUCTION	2
B. DIVISIONS OF THE ANALYSIS	
BLOCK I - Engine Lathe Practice	5A
BLOCK II (A) - Shaper Practice	59
BLOCK II (B) - Slotter Practice	78
BLOCK III - Benchwork and Fitting Practice	87
BLOCK IV - Drill Press Practice	148
BLOCK V - Milling Machine Practice	166
BLOCK VI - Planer Practice	192
BLOCK VII - Heat Treating Practice	213
BLOCK VIII - Grinding Practice	226
BLOCK IX - Sawing Practice	257
BLOCK X - Properties and Uses of Materials	269
C. APPENDIX:	
BLOCK XI - Turret Lathe Practice	297
BLOCK XII (A)- Vertical Boring Mill Practice	315
BLOCK XII (B)- Horizontal Boring Mill Practice	340
BLOCK XIII - Broaching Practice	355
BLOCK XIV - Blueprint Reading and Shop Sketching.	368
BLOCK XV (A) - Practical Shop Mathematics (Fundamental)	386
BLOCK XV (B) - Practical Shop Mathematics (Problems)	391

I N T R O D U C T I O N

The first National Conference on Apprenticeship in Trades and Industries held at Ottawa in May 1952, recommended that the Federal Government be requested to co-operate with Provincial apprenticeship committees and officials in preparing analyses of a number of skilled occupations.

In implementing the above recommendation the Training Branch of the Federal Department of Labour appointed a committee of five persons in British Columbia to prepare an analysis of the Machinist's Trade. This committee was organized in September 1953 and included Mr. J. H. Dalglish, Supervisor of Technical Education, Victoria, B.C.; Mr. G. W. Lidster, Machine Shop Instructor, Vocational Institute, Vancouver; Mr. W. N. Matthews, Machine Shop Instructor, Vancouver Technical High School; Mr. D. L. Smith, Machine Shop Instructor, Vancouver School Board, Mr. H. A. Jones, Director of Vocational Education, Chairman.(Since superannuated.)

SCOPE OF ANALYSIS

Because the practice of this trade varies province to province, it was decided to set forth from the original comprehensive analysis only those phases of the trade that are considered essential in each and every province. In other words, this compilation is the analysis reduced to a point such that officials in no province would eliminate any part as being non-essential to the trade in that province. Because it sets forth a body of skills and information common to all sections of Canada and which should be mastered by trainees during their period of apprenticeship, it forms what may be termed the common hard core. It should be noted that this final analysis is not a

course of study nor is it intended that operations be undertaken in the sequence shown.

Certain basic studies that are not particularly peculiar to this trade alone have purposely not been included although facility in same is essential and should not be overlooked in the overall program. Such studies include Mathematics, Science and Blueprint Reading. However, these have been included in the Appendix.

Any persons desiring further information regarding the original comprehensive analysis may secure same by applying to the Director of Vocational Education, Victoria, B. C.

In this trade, there are advanced activities carried out on specialized equipment in varying degrees of intensity, province to province in Canada and no attempt has been made to include these in the body of common essential operations.

The science relating to some of these operations is an outgrowth of the principles which are basic in the operation of the ordinary tools so universally used such as the engine lathe, the milling machine and others.

The operation of each and every specialized or advanced tool cannot be considered within the scope of the training of a person during the period of his apprenticeship. However, the committee has decided to include certain machines in the appendix and recommend that as circumstances permit, apprentices be given information regarding these specialized operations as well as an opportunity of gaining skill therein.

PROCEDURE

In carrying out the general plan, the steps indicated below were taken so that the result would be nationally acceptable. As the national committee completed each block it was sent to officials in the various

provinces for examination. All suggestions received were considered and in the light of same the committee reviewed their former efforts and later the revised analysis was sent to the Director of Apprenticeship in each province for study by a committee or committees of his choice.

On the basis of these studies, the compilation herewith can be considered the National Analysis of the Machinist's Trade reduced to the minimum essential content, or common hard core. As such, it gives scope for any province to add features from those indicated in the Appendix so that their apprentices will be familiar with and skilled in all phases of the trade as practised in that province.

This analysis comprises a series of Blocks each of which is quite independent of other Blocks. Each Block is a group of related units divided into a number of operations with related knowledge indicated. A code system is used by which Block two, Unit one, Operation eight for example would be represented by the following $B_2 U_1 O_8$.

PURPOSES AND USES OF ANALYSIS

The committee recommends this analysis as (1) a guide to foremen and others who train apprentices on the job; (2) a guide to those who instruct apprentices during their in-school periods; (3) the basis of completion examinations for apprentices; (4) a means of transferring apprenticeship credits province to province; (5) a basis for courses of study in vocational schools, tradesinstitutes, or in industry; (6) a basis of evaluating previous experience in the qualifying of journeymen.

The committee hopes that this effort will contribute to the development of apprenticeship training nationally and desires to express its

appreciation to officials of the Training Branch of the Department of Labour, Ottawa for their co-operation and guidance in this project. Thanks are also due to the many Advisory Committees and individuals in other provinces who gave freely of their time and experience in submitting comments and suggestions which were of great assistance.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I - ENGINE LATHE PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	6
Unit 2. Work Holding Techniques.....	7
Unit 3. Facing Techniques.....	10
Unit 4. Turning Techniques.....	12
Unit 5. Drilling Techniques.....	18
Unit 6. Boring Techniques.....	24
Unit 7. Reaming Techniques.....	31
Unit 8. Threading Techniques.....	36
Unit 9. Knurling Techniques.....	49
Unit 10. Filing and Polishing Techniques.....	50
Unit 11. Rolling and Burnishing Techniques.....	53
Unit 12. Miscellaneous Techniques.....	54

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT I: THE MACHINE

OPERATIONS

KNOWLEDGE

- | | |
|-----------------------------|--|
| 1. Oiling the machine. | (a) Features and functions of parts.
(b) Kinds, uses and selection of lubricants.
(c) Lubrication methods and procedures.
(d) Frequency of lubrication e.g. parts oiled daily, weekly, etc.
(e) Types, features and uses of lubricating equipment.
(f) Statistical control of lubricating e.g. schedules, charts, etc. |
| 2. Controlling the machine. | (a) Features and functions of control mechanisms.
(b) Systems and uses of "color Dynamics" e.g. some standard for moving parts, control levers, etc.
(c) Interpretation of manufacturers' specifications and instructions e.g. operators' manual.
(d) Operating precautions e.g. gear changing, half-nut lever, etc.
(e) Safety Practices e.g. "check-points" prior to starting. |
| 3. Cleaning the machine. | (a) Types and uses of solvents and cleaners.
(b) Cleaning techniques.
(c) Effects of cutting-compounds on machine parts i.e. sulphur base, soluble oils, etc.
(d) Precautions re use of compressed air.
(e) Safety practices re hygiene and accidents. |
| 4. Adjusting the machine. | (a) Methods of adjusting moving parts.
(b) Methods of compensating for wear.
(c) Types, features and functions of tools used e.g. mechanics tools, torquometer, etc.
(d) Methods, procedures and equipment for testing the lathe.
(e) Causes of errors in lathework.
(f) Allowances for fits in stationary and moving parts.
(g) Methods of truing the spindle nose.
(h) Methods of testing and adjusting thrust bearing. |

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 2: WORK-HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work.	<ul style="list-style-type: none"> (a) Selecting the machine and accessories. (b) Types and uses of "raising-blocks". (c) Type of operation to be performed. (d) Accuracy required on the job. (e) Fragility of the work-piece. (f) Weight, size and shape of the work-piece. (g) Quantity of parts to be made. (h) Machine capacity and capability.
2. Setting-up work in chucks such as:	<ul style="list-style-type: none"> (a) Types, features, functions and limitations of chucks, collets, jigs and fixtures. (b) Chucking procedures, e.g. clean chuck and work, de-burr, etc. (c) Methods of counterbalancing. (d) Chucking fixtures and soft jaws, e.g. stock adaptor bushing, soft center, etc. (e) Spindle-end supports (outboard). (f) Types and uses of indicating equipment. (g) Method of supporting long work, internally and externally. (h) Types and uses of de-magnetizing equipment. Physics - Magnetism (i) Methods of compensating for wear in chucks. (j) Methods of feeding heavy bars through the spindle. (k) Methods of supporting work while mounting e.g. tailstock ram, carriers, etc. (l) Methods of retarding chuck wear e.g. jaw liners, etc. (m) Pressure required for holding work. (n) Operating precautions re work overhang. Mechanics - Moments & deflection (o) Operating precautions re distortion of thin walled work. (p) Safety practices re hazards.
<ul style="list-style-type: none"> (a) 2-jaw (universal) (b) 3-jaw (universal) (c) 4-jaw (independent) (d) collets (e) combination (3-jaw and 4-jaw) 	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 2: WORK-HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Setting-up work on a faceplate.	<ul style="list-style-type: none"> (a) Types, features and functions of face plates. (b) Types and uses of faceplate fixtures, jigs and accessories e.g. strips, angle plates, etc. (c) Methods of preventing slippage e.g. paper, stops, etc. (d) Methods of testing and truing faceplates. (e) Methods of supporting work while clamping. (f) Clamping devices. Mechanics - Moments, Friction. (g) Counterbalancing. Mechanics - Centrifugal Force. (h) Precision set-up procedures e.g. master plates, strips and spacers, microscope, etc. (i) Operating precautions e.g. use of carriage stops, etc. (j) Safety Practices - Smashed fingers, support cradles, etc.
4. Setting-up work on centers.	<ul style="list-style-type: none"> (a) Preparation of the work for mounting. (b) Types, features and functions of lathe centers, such as male, female, ball-bearing, etc. (c) Kinds and applications of lubricants. (d) Methods of pressure lubrication. (e) Types, features and functions of driver plates and dogs. (f) Methods of heat dissipation. Physics - expansion. (g) Methods of supporting long work, heavy and light. (h) Methods of testing and truing lathe centers. (i) Methods of straightening work e.g. heating and quenching, peening, etc. (j) Methods of aligning a tailstock. (k) Testing and changing location of center holes. (l) Types and applications of center spiders and bridges. (m) Types and uses of single ball centers. (n) Methods of applying lubricants. (o) Types and characteristics of lubricants for centers. (p) Types, uses and care of long range indicators. (q) Operating precautions. Physics - the viscous circle of heat.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 2: WORK-HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Setting-up work on mandrels, such as:</p> <p>plain stub expanding adjustable gang special purpose e.g. soft mandrels.</p>	<p>(a) Types, features and functions of mandrels. (b) Preparation of work for mounting on mandrels. (c) Methods of driving mandrel-mounted work. (d) Lubrication of mandrels. (e) Inspection, care and storage of mandrels. (f) Methods of testing mandrels for accuracy e.g. dial indicator, micrometer, etc. (g) Methods of straightening bent mandrels e.g. press, torch-spotting. (h) Methods of grinding and lapping center holes. (i) Types and features of thread rolling mandrels i.e. internal roll or die. (j) Method of truing mandrels. (k) Operating precautions. Physics - Heat.</p>
<p>6. Setting-up work on the carriage.</p>	<p>(a) Types and uses of saddle and cross-slide fixtures. (b) Types and uses of center mounted boring bars and accessories. (c) Procedures in truing-up e.g. tramming or indicating. (d) Set-up procedures. (e) Types and operation of lifting equipment. (f) Types of work requiring carriage mounting. (g) Safety practices. Hazards.</p>
<p>7. Setting-up work in the steady rest.</p>	<p>(a) Types, features and functions of steady rests. (b) Methods of aligning work in a steady rest. (c) Methods of lubricating steady rests. (d) Procedures in the use of steady rests. (e) Steady rest accessories e.g. a cat head, a bushing, special jaws, etc. (f) Methods of heat dissipation. Physics - Heat. (g) Types of work requiring steady rest mounting. (h) Methods of driving steady-rest mounted work. (i) Precautions re clamping of steady rest.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 2: WORK-HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
8. Setting-up work on the bed.	<ul style="list-style-type: none"> (a) Types, features, and functions of bed-mounted fixtures. (b) Types of work requiring bed-mounting. (c) Set-up procedures. (d) Methods of feeding work or tools. (e) Types and features of clamping devices. (f) Mechanics of clamping - Physics.
9. Setting-up work on the spindle nose.	<ul style="list-style-type: none"> (a) Features and functions of standard spindle noses. (b) Kinds, features and uses of spindle nose adaptors and fixtures. (c) Care of spindle throat and nose. (d) Types and uses of draw-in bolts.

BLOCK I: ENGINE LATHE PRACTICE

UNIT 3: FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Facing or squaring. Work held: in a chuck on a faceplate in a steady rest on the spindle nose	<ul style="list-style-type: none"> (a) Methods of mounting work, as B1, U2, O2, 3, 7 & 9. (b) Selection of cutting tools for power facing and/or squaring. (c) Methods of mounting tools. Physics - Moments, forces. (d) Facing and squaring procedures: hand and power feeds, rough and finish cuts, etc. (e) Types, uses and applications of cutting compounds. (f) Cutting speeds and feeds. (g) Selection of cutting speeds. Use of handbook. (h) Methods of measuring speed, e.g. types and uses of tachometers; stroboscope, etc. (i) Methods of testing surfaces. Use of straight-edge, templates, etc. (j) Types of faces e.g. angular, convex, concave, flat, etc. (k) Methods of machining curved surfaces e.g. forming, angular turning, template, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 3: FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (cont'd.)	<ul style="list-style-type: none"> (l) Calculating length of pivot pins. (m) Production methods e.g. spindle stops, carriage stops, etc. (n) Methods of measuring length. (o) Types, uses and care of measuring instruments. (p) Procedures in facing to a shoulder. (q) Methods of supporting hand tools. (r) Speeds for freehand facing. (s) Types and features of freehand facing tools. (t) Kinds of metals suitable for freehand facing. (u) Methods of testing spindle thrust bearing. (v) Operating precautions e.g. tool gouging, etc. (w) Operating precautions re chatter. (x) Operating precautions re work overhang e.g. tool breakages, etc. (y) Safety practices e.g. feed mechanism hazards, clothing and flying pieces, etc.
2. Facing or squaring. Work held on centers.	<ul style="list-style-type: none"> (a) Methods of mounting work, as B1, U2, O4 (b) Selection of tools. (c) Types and uses of cutaway centers. (d) Methods of measuring length. (e) Methods of aligning tailstock. (f) Precision facing by the compound slide method. (g) Methods for testing accuracy of cross-slide. (h) Methods of freehand facing. (i) Safety practices - Lathe dog hazard.
3. Facing or squaring. Work held on mandrels.	<ul style="list-style-type: none"> (a) Methods of mounting work, as B1, U2, O5. (b) Types and uses of straddle tools. (c) Preparation of work for facing on a mandrel e.g. chamfered bore, etc. (d) Types and features of compensating washers e.g. for facing nuts, etc. (e) Operating precautions in the use of mandrels. (f) Operating precautions re driving mandrel-mounted work. Physics - Friction. (g) Operating precautions re grabbing of hand facing tools.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 3: FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Facing or squaring. Work held on the carriage.	(a) Methods of mounting work, as B1, U2, 06 and 10. (b) Types, features and functions of facing heads. (c) Design of tools for form-facing. (d) Using the compound slide on the faceplate. (e) Feeds and speeds for facing operations. (f) Methods of feeding tools, e.g. star-wheel, etc. (g) Types and uses of fly cutters and holders. (h) Safety practices. Rotating cutter hazard.
5. Backfacing. Work held: in a chuck, on a faceplate.	(a) Methods of mounting work, as B1, U2, 02, 3. (b) Methods of backfacing. (c) Types and features of backfacing tools. (d) Care of lathe and equipment when working blind. (e) Method and instruments for measuring from inside faces. (f) Operating precautions re tool overhang, speed, grabbing, etc.

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Parallel turning. Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.	(a) Methods of mounting work, as B1, U2, 02, 3, 7, 9. (b) Types, features and functions of turning tools - single point. (c) Methods of mounting tools. Physics - Mechanics, forces. (d) Turning procedures; feed mechanisms; power and/or hand feed, etc. (e) Types, uses and applications of cutting compounds. Chemistry & Physics - Testing cutting oils. (f) Cutting speeds and feeds. (g) Types and uses of measuring instruments for diameter e.g. direct and indirect.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (cont'd.)	<ul style="list-style-type: none"> (h) The effect of the generation of heat. Physics - Expansion. (i) Types of surface finishes for roughing and finishing. (j) Position of the tool-bit for rough and finish turning. (k) Production methods e.g. carriage and cross slide stops, etc. (l) Types and uses of plunge-cut tools. (m) Methods of chip control and disposal. (n) Types, features, and functions of Multiple tooling set-ups. (o) Calculations for turning time. (p) Types and uses of hollow mills. (q) Translation of English Graduations to provide metric in-feed e.g. by setting compound slide. (r) Allowances for finish e.g. tool and grinder finish. (s) Principles of metal cutting. (t) Method of turning extra large diameters, e.g. boring bar, etc. (u) Layout tool and procedures e.g. marking shoulders, grooves, lands, etc. (v) Types and features of freehand turning tools. (w) Speeds for freehand turning. (x) Freehand turning procedures. (y) Types and features of freehand turning tool rests. (z) Recognition of burned and dull tools. (aa) Operating precautions re turning press-fits e.g. establish size, etc. (ab) Operating precautions re position of tool holder e.g. to clear moving parts. (ac) Operating precautions re chatter. Physics - Resonance. (ad) Operating precautions re Interrupted cuts. (ae) Operating precautions re turning to a shoulder e.g. tool breakage, undercut, etc. (af) Safety practices. Feed mechanisms, chip and clothing hazards.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Parallel turning.</p> <p>Work held: on centers, on a mandrel.</p>	<p>(a) Methods of mounting work, as B1, U2, O4, 5. (b) Methods of tailstock alignment. (c) Types, features and functions of follower rests. (d) Methods of balancing driving torque e.g. use of a double tail dog and equalizer plate. (e) Bending effect re driving dogs. (f) Special methods of parting off ganged work e.g. Trepanning setting. (g) Type of center for freehand work e.g. ball bearing center. (h) Methods of testing and truing bent work. (i) Methods of preserving lead screw accuracy, e.g. extension live center. (j) Methods of locating shaft centers. (k) Machinability of materials. (l) Operating precautions re turning to a layout. (m) Operating precautions re mandrel mounted work. Physics - Friction, Heat, direction of cut. (n) Safety precautions re lathe dog hazards.</p>
<p>3. Taper turning.</p> <p>Work held: in a chuck on a faceplate on a mandrel (stub type) on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 5, 9. (b) Types, features and functions of tapers. Standards, etc. (c) Taper calculations. (d) Methods of setting the compound slide. (e) Methods and devices for turning tapers, e.g. taper attachment, offhand, etc.; advantages and limitations of each. (f) Methods of testing and measuring tapers. (g) Methods of mounting and positioning cutting tools, i.e. height, trailing, etc. (h) Types and uses of forming tools. (i) Methods of fitting a taper. (j) Procedures for turning tapers. (k) Production methods of cutting tapers. (l) Combination feed method calculations. (m) Types, features and uses of freehand tapered work. (n) Methods of tool control in freehand taper turning. (o) Types, features and methods of mounting rests for freehand work.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. (cont'd.)	<p>(p) Types, features and uses of surface high spot indicators e.g. Mechanics Blue, red lead, alcohol, etc.</p> <p>(q) Production methods re composite tapers e.g. taper attachments and compound, etc.</p>
<p>4. Taper turning.</p> <p>Work held: on centers, on a mandrel.</p>	<p>(a) Methods of mounting work as B1, U2, O4, 5.</p> <p>(b) Uses and limitations of the setover method.</p> <p>(c) Calculations of setover.</p> <p>(d) Effect of setover on center holes and centers.</p> <p>(e) Differential action of driving dogs on set-over work.</p> <p>(f) Methods of measuring set-over.</p> <p>(g) Types, uses and limitations of taper attachments.</p>
<p>5. Parting, grooving and/or necking.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, and 9.</p> <p>(b) Types and uses of grooves and undercuts.</p> <p>(c) Types and uses of groove-turning tools.</p> <p>(d) Types and applications of shoulders.</p> <p>(e) Methods and tools for measuring grooves.</p> <p>(f) Types, uses and applications of parting tools.</p> <p>(g) Speeds and feeds for parting, necking and grooving.</p> <p>(h) Types and uses of spring tool-holders.</p> <p>(i) Types and uses of multiple tool holders.</p> <p>(j) Methods of Helical grooving.</p> <p>(k) Types and features of freehand parting, grooving and/or necking tools.</p> <p>(l) Method and position of holding freehand tools.</p> <p>(m) The press and release method of grooving with freehand tools.</p> <p>(n) Operating precautions re binding and complete cut off.</p> <p>(o) Precautions re use of tipped freehand tools e.g. snagging, etc.</p> <p>(p) Operating precautions re side relief in deep grooving e.g. step method, etc.</p> <p>(q) Safety practices re flying and falling pieces.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>6. Turning and/or forming contours.</p> <p>Work held: in a chuck, on a faceplate, on a mandrel, on centres, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, 3, 4, 5, 7, and 9.</p> <p>(b) Freehand forming methods, use of templates, etc.</p> <p>(c) Types and uses of tools for offhand forming i.e. when using carriage, toolholder, etc.</p> <p>(d) Types and applications of circular, flat and dovetail forming tools, etc.</p> <p>(e) Types and applications of skiving tools.</p> <p>(f) Speeds and feeds for forming.</p> <p>(g) Types and applications of contour plates, followers and tracer points.</p> <p>(h) Production methods and procedures.</p> <p>(i) Methods of Testing and measuring contours e.g. shadowgraph.</p> <p>(j) Types and features of freehand forming tools.</p> <p>(k) Correct rake positions for hand forming.</p> <p>(l) The rocking method of freehand roughing.</p> <p>(m) Methods of forming with the graver tool.</p> <p>(n) Speeds for freehand forming.</p> <p>(o) Care in reproducing profile of hand formers.</p> <p>(p) Template layout procedures.</p> <p>(q) The use of half-profile patterns as a turning guide.</p> <p>(r) Method of setting calipers to pattern e.g. ornamental work.</p> <p>(s) Methods of turning beads and cove cuts.</p> <p>(t) Types and features of scrapers for finishing.</p> <p>(u) Operating Precautions re seized centers.</p> <p>Physics - Heat</p>
<p>7. Spherical turning.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, 02, 3, 4, 5, 9.</p> <p>(b) Types, features and functions of spherical turning-tool attachments.</p> <p>(c) Types and applications of spherical forming tools.</p> <p>(d) Spherical turning procedures.</p> <p>(e) Calculating weight, volume, etc. of a sphere.</p> <p>(f) Checking Mass of Materials.</p> <p>Physics - Specific Gravity.</p> <p>(g) Methods of measuring and testing spheres.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
7. (cont'd.)	<ul style="list-style-type: none"> (h) Freehand methods of turning a sphere. (i) Types and features of tube-tools. (j) Methods of scraper finishing a sphere. (k) Types and features of spherical turning fixtures. (l) Operating precautions re chatter.
8. Eccentric turning. Work held: in a chuck, on a faceplate, on centers, on a mandrel, on a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, O3, 4, 5, 7, 9. (b) Lay-out procedures. (c) Methods of offsetting. (d) Calculations for offsetting. (e) Methods of measuring offset. (f) Types and uses of throw blocks. (g) Speeds and feeds for eccentric turning. (h) Types and uses of pin turning tools. (i) Method of preventing spring in crankshaft work. (j) Types of steady rests for crankshaft work. (k) Methods of mounting tools. (l) Types and uses of reach-over tool posts. (m) Types and features of eccentric bushings. (n) Safety practices re correct speed to prevent throw-out.
9. Turning an angular surface. Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, and 9. (b) Types, features and functions of angular surfaces e.g. valve faces, centers, etc. (c) Methods of setting compound slide. (d) Methods of calculating angular surfaces. (e) Methods and devices for turning angular surfaces. (f) Methods of measuring and testing angles. (g) Production methods of turning angular surfaces. (h) Speeds for angular turning.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 4: TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
10. Chamfering and/or rounding a corner. Work held: in a chuck, on a faceplate, on centers, on a mandrel, in the steady rest, on the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, and 9. (b) Types and uses of chamfers and radii. (c) Types, features and functions of lathe files. (d) Speed of work for filing. (e) Types and features of corner forming tools. (f) Types and uses of radius gauges. (g) Speeds for forming. (h) Type and application of lubricant e.g. lard oil, etc. (i) Methods of freehand cornering e.g. scraper, file, hand former, etc.

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Spotting for drilling. Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Types, features and functions of spotting tools. (c) Methods and theory of spotting. (d) Selection of speeds and feeds. (e) Cutting lubricants. (f) Specifications e.g. accuracy for set-up. (g) Selection of spotting drills e.g. to avoid breakage; correct size, etc. (h) Types and features of freehand spotting tools. (i) Freehand spotting procedures. (j) Kinds of work usually spotted freehand e.g. art metalwork.
2. Spotting for drilling. Work held: on the carriage, in the tailstock.	(a) Methods of mounting work as B1, U2, O6, 8, 10. (b) Methods of mounting spotting tools. (c) Methods of controlling size of spot. (d) Methods of feeding work or tool.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Spotting for drilling.</p> <p>Work held: by hand</p>	<p>(a) Methods of supporting work held by hand e.g. reversed tool holder, etc.</p> <p>(b) Lay-out procedures.</p> <p>(c) The necessity of heavy center punching.</p> <p>(d) Use of the combination drill as a pilot for accurate work.</p> <p>(e) Types, features and uses of tailstock attachments e.g. vise; crotch-center; drill pads, etc.</p> <p>(f) Precautions re work slippage i.e. work spins, drill breaks, etc.</p>
<p>4. Center drilling.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, features and specifications of combination drills and countersinks.</p> <p>(c) Types and uses of center reamers.</p> <p>(d) Types and applications of square centers e.g. rough work.</p> <p>(e) Types and uses of single point centering tools.</p> <p>(f) Preparation of work for centering e.g. flat face, safety counterbore, etc.</p> <p>(g) Layout tools and procedures.</p> <p>(h) Speeds and feeds for centering.</p> <p>(i) Types and uses of lubricants.</p> <p>(j) Types, features and functions of center holes.</p> <p>(k) Methods of testing and truing center holes.</p> <p>(l) Precautions re drill breakage e.g. lubrication, chip removal, cutting speeds, etc.</p>
<p>5. Center drilling.</p> <p>Work held: in the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of sensitive drilling e.g. sliding quill, etc.</p> <p>(c) Center drilling procedures.</p> <p>(d) Safety practices.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>6. Center drilling.</p> <p>Work held: by hand.</p>	<p>(a) Methods of holding work by hand.</p> <p>(b) Methods of supporting hand held work e.g. tailstock, steady rest, etc.</p> <p>(c) Center drilling procedures.</p> <p>(d) Types and features of work-centering devices.</p> <p>(e) Methods of controlling depth.</p> <p>(f) Precautions re breakage of center drills e.g. lack of speed, etc.</p> <p>(g) Safety practices e.g. slipping off center, grabbing, etc.</p>
<p>7. Drilling a round through hole from solid.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9, 11.</p> <p>(b) Types, features and functions of drills.</p> <p>(c) Methods of holding and removing drills e.g. sleeves, sockets, chucks, etc.</p> <p>(d) Methods and theory of drilling.</p> <p>(e) Selection of speeds and feeds. Use of tables.</p> <p>(f) Coolants and lubricants for drilling various materials.</p> <p>(g) Methods of applying lubricants and coolants.</p> <p>(h) Chip control and disposal.</p> <p>(i) Methods of feeding a drill.</p> <p>(j) Specifications e.g. accuracy of hole.</p> <p>(k) Methods of measuring and gauging holes.</p> <p>(l) Types, features and functions of measuring and gauging instruments.</p> <p>(m) Tailstock and toolpost mounted drilling accessories.</p> <p>(n) Diagnosis and correction of drill troubles.</p> <p>(o) Methods of drilling long small holes e.g. 1/8" x 10".</p> <p>(p) Methods of drilling part holes.</p> <p>(q) Methods of drilling oversize holes e.g. off-angle drill points, off center drill points, etc.</p> <p>(r) Precaution re clearing drill flutes.</p> <p>(s) Precautions re gauging and measuring.</p> <p>(t) Precautions re breakthrough and spring-back.</p> <p>(u) Precautions re tailstock alignment.</p> <p>(v) Safety practices.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>8. Drilling a round through hole from solid.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work, as B1, U2, O6, 8, 10.</p> <p>(b) Methods of holding and driving drills.</p> <p>(c) Drilling procedures.</p> <p>(d) Methods of feeding work.</p> <p>(e) Precautions re starting drill true. e.g. condition of drill, spot, etc.</p> <p>(f) Safety practices.</p>
<p>9. Drilling a round blind hole from solid.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9, 11.</p> <p>(b) Methods of controlling depth.</p> <p>(c) Methods of measuring and gauging depth.</p> <p>(d) Types and functions of bottoming tools.</p> <p>(e) Production methods, e.g. stops, dial gauges, etc.</p> <p>(f) Types and uses of drill extensions.</p> <p>(g) Types and uses of spindle bushings.</p> <p>(h) Methods of driving and feeding.</p> <p>(i) Chip control and disposal.</p> <p>(j) Application of coolant.</p>
<p>10. Drilling a round blind hole from solid.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of controlling depth.</p> <p>(c) Production methods.</p>
<p>11. Drilling a round hole from solid.</p> <p>Work held by hand.</p>	<p>(a) Methods of holding and supporting work e.g. steady rest, hoists, etc.</p> <p>(b) Layout procedures.</p> <p>(c) Reasons for holding work by hand.</p> <p>(d) Necessity for full size spotting.</p> <p>(e) Methods of drilling in alignment.</p> <p>(f) Types, features and functions of special centers e.g. crotch center, drill pad, etc.</p> <p>(g) Methods of flood-cooling for small diameter work.</p> <p>(h) Types and features of drill points for deep-hole drilling.</p> <p>(i) Types and features of extension drills.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
11. (cont'd.)	<ul style="list-style-type: none"> (j) Methods of holding and driving drills. (k) Precautions re drill breakage e.g. small drills; through holes, etc. (l) Safety practices e.g. work slippage.
12. Drilling a round cored through hole. Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 7, 9, 11. (b) Types, features and functions of special drills. (c) Drilling procedures. (d) Speeds and feeds. (e) Precautions re starting drills. (f) Precautions re cored holes e.g. warped, shrinkholes, sand, etc.
13. Drilling a round cored through hole. Work held: on the carriage, in the tailstock.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O6, 8, 10. (b) Methods of starting drills e.g. counter-bore, etc. (c) Drilling procedures. (d) Preparation of cored hole for drilling e.g. cleaning, chipping, etc. (e) Precautions re drill running.
14. Drilling a round cored blind hole. Work held: in a chuck, on the faceplate, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Drilling procedures. (c) Precautions re drill breakage e.g. cave-in, etc.
15. Drilling a round cored blind hole.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O6, 8, 10. (b) Methods of testing cored hole for alignment. (c) Methods of supporting large drills e.g. sliding guide, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>16. Bottoming a round blind hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, features and functions of bottoming tools.</p> <p>(c) Types and uses of hole-bottoms.</p> <p>(d) Cutting speeds for forming.</p> <p>(e) Application of cutting lubricants.</p> <p>(f) Methods of testing and inspecting blind hole bottoms e.g. templates, mirrors, etc.</p> <p>(g) Precautions re-chip interference.</p>
<p>17. Bottoming a round blind hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work, as B1, U2, O6, 8, 10.</p> <p>(b) Methods of feeding work and tools.</p> <p>(c) Reasons for running in reverse. e.g. carriage shudder.</p> <p>(d) Precautions re chatter and tool breakage.</p>
<p>18. Drilling a stepped round hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Designs and uses of stepped holes.</p> <p>(c) Types, features and functions of step-drilling tools.</p> <p>(d) Procedures in step-drilling.</p> <p>(e) Methods of chip control.</p> <p>(f) Types and uses of spindle pilot-bushings.</p>
<p>19. Drilling a stepped round hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work, as B1, U2, O6, 8, 10.</p> <p>(b) Types and uses of piloted tools.</p> <p>(c) Methods of measuring obstructed holes.</p> <p>(d) Production methods e.g. carriage stops, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 5: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>20. Counterboring, countersinking or spot-facing holes.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and features of counterbores, countersinks and spot-facing tools.</p> <p>(c) Counterboring, countersinking and spot-facing procedures.</p> <p>(d) Methods of controlling depth.</p> <p>(e) Production methods.</p> <p>(f) Cutting speeds for counterboring, countersinking and spot-facing.</p> <p>(g) Methods of preventing and eliminating chatter.</p> <p>(h) Combination drills and countersinks.</p> <p>(i) Combination drills and counterbores.</p> <p>(j) Combination drills and spot facing tools.</p> <p>(k) Precautions re binding of pilots.</p>
<p>21. Counterboring, countersinking or spot-facing holes.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of controlling depth e.g. carriage stops, bar gauges, etc.</p> <p>(c) Methods of testing and inspecting.</p> <p>(d) Counterboring, countersinking and spot-facing procedures.</p> <p>(e) Precautions re seizing of pilots.</p>

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Boring a through parallel hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Design of boring bars, boring heads, and boring tools.</p> <p>(c) Methods of mounting tools. Physics - Moments, forces.</p> <p>(d) Boring procedures.</p> <p>(e) Cutting speeds and feeds.</p> <p>(f) Types, uses and applications of cutting compounds.</p> <p>(g) Methods of measuring bores.</p> <p>(h) Types and uses of measuring instruments for bores. Gauges, micrometer, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (Cont'd.)	<ul style="list-style-type: none"> (i) Production methods e.g. Turret-head, dial clips, etc. (j) Methods of chip control and disposal e.g. helix on boring bars, wire coils, etc. (k) Methods of measuring speeds e.g. tachometer, etc. (l) Methods of testing and inspecting surface finishes. (m) Types and uses of hand-scraping tools. (n) Methods of keeping a bore parallel. (o) Methods of preparing split work for boring. (p) Types and uses of spindle pilot bushings. (q) Relation of bar size to bore size. (r) Methods of lubricating pilot bushings and bars. (s) Types and features of lubricants. (t) Speeds for freehand boring and scraping. (u) Reasons for scraping bores. (v) Types and features of scrapers for finishing bores. (w) Types and features of hand bore tool rests. (x) Types and features of freehand boring tools. (y) Methods of freehand boring. (z) Operating precautions re chatter. Physics - Resonance. (aa) Operating precautions re plug gauges. Physics - Heat. (ab) Operating precautions re interrupted cuts e.g. negative rake, etc. (ac) Operating precautions. Care of machine and accessories e.g. spindle nose, faceplate, etc. (ad) Safety practices re tools, fingers and rags in hole.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Boring a blind parallel hole.</p> <p>Work held: in a chuck, on the faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Methods of mounting tools.</p> <p>(c) Selection of tools.</p> <p>(d) Methods of controlling the depth of bore.</p> <p>(e) Methods of measuring and gauging depth.</p> <p>(f) Boring procedures.</p> <p>(g) Types, features, functions and care of depth measuring tools.</p> <p>(h) Production methods e.g. dial stops, bar gauge, etc.</p> <p>(i) Methods of chip control and disposal.</p> <p>(j) Freehand boring procedures.</p> <p>(k) Methods of boring from solid stock.</p> <p>(l) Advantages of the "scooping" method.</p> <p>(m) Methods of bottoming blind holes freehand.</p> <p>(n) Operating precautions re chatter e.g. square bottom; contoured, etc.</p> <p>(o) Operating precautions re bottoming.</p> <p>Physics - Forces.</p> <p>(p) Safety practices re use of air blast and goggles.</p>
<p>3. Boring a blind parallel hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Types and uses of faceplate and chuck-mounted cutters.</p> <p>(c) Types and uses of offset boring heads.</p> <p>(d) Types and uses of spindle-mounted cutters.</p> <p>(e) Methods of feeding tools.</p>
<p>4. Counterboring and step boring.</p> <p>Work held: in a chuck, on a faceplate, on centers, in a steady rest, on a mandrel, in a spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 5, 7, 9, 11.</p> <p>(b) Types of tools and heads for counterboring.</p> <p>(c) Counterboring procedures.</p> <p>(d) Methods of measuring and gauging, counterbores.</p> <p>(e) Production methods e.g. multiple stops.</p> <p>(f) Speeds and feeds for counterboring.</p> <p>(g) Methods of freehand counterboring.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. (Cont'd.)	<ul style="list-style-type: none"> (h) Types and features of hand counterboring tools. (i) Kinds of material and work most suitable for hand tooling.
5. Counterboring and step boring. Work held: on the carriage, on the tailstock.	<ul style="list-style-type: none"> (a) Methods of mounting work, as B1, U2, O6, 8, 10. (b) Types and uses of multi-tool heads. (c) Types and uses of revolving forming tools.
6. Boring a through tapered hole. Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Types, specifications and nomenclature of standard tapers. (c) Methods of taper boring. (d) Calculations for tapers; compound slide taper attachment. (e) Calculations for setover. (f) Methods of tool feeding for the offset method. (g) Position of tool for taper boring. (h) Methods of testing and measuring taper bores. (i) Speeds and feeds for taper boring. (j) Types and uses of taper forming tools. (k) Methods of driving offset steady rest work. (l) Standard taper fits. (m) Uses of taper press fits. (n) Classification of tapers re sticking, releasing. (o) Methods of freehand taper boring. (p) Types of work bored freehand e.g. art metalwork. (q) Types and features of scrapers for finishing tapered bores. (r) Operating precautions re tool clearances.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>7. Boring a through tapered hole.</p> <p>Work held on the carriage.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 10.</p> <p>(b) Types and uses of adjustable live centers.</p> <p>(c) Calculations for setover.</p> <p>(d) Methods of offsetting the live centers.</p> <p>(e) Methods of tool feeding in the offset method.</p> <p>(f) Uses of relieved tapered bores.</p> <p>(g) Types and uses of tapered travelling cutter bars.</p>
<p>8. Boring a blind tapered hole.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, in the tailstock, in the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 8, 9.</p> <p>(b) Precautions re interrupted cut.</p> <p>(c) Types and uses of undercuts e.g. center relief, etc.</p> <p>(d) Methods of gauging blind tapers.</p> <p>(e) Reasons for scraping tapers.</p> <p>(f) Methods of freehand boring blind tapered holes.</p> <p>(g) Uses and limitations of freehand boring methods.</p> <p>(h) Operating precautions re bottoming.</p> <p>(i) Safety practices re grabbing hazard.</p> <p>(j) Safety practices to prevent hand tool jamming.</p>
<p>9. Boring a blind tapered hole.</p> <p>Work held on the carriage.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 10.</p> <p>(b) Methods of setting boring bars, sine bars, templates, etc.</p> <p>(c) Calculations for sine bars.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>10. Boring a stepped tapered hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Uses of stepped taper bores.</p> <p>(c) Methods of step-boring.</p> <p>(d) Types and tools for step taper boring.</p> <p>(e) Types and uses of gauges for testing and measuring.</p>
<p>11. Boring a through angular hole.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, in the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Kinds of sticking and releasing tapers.</p> <p>(c) Template method of testing angles.</p> <p>(d) Types of boring tools.</p> <p>(e) Freehand boring methods.</p> <p>(f) The place of freehand boring in lathe work.</p>
<p>12. Boring a stepped angular hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and uses of stepped angular holes.</p> <p>(c) Methods of avoiding distortion.</p> <p>(d) Types and uses of special forming tools.</p> <p>(e) Methods of testing and measuring steps for depth, angle, diameter.</p> <p>(f) Freehand boring procedures.</p> <p>(g) Methods of scraping by hand.</p>
<p>13. Oil grooving a through or blind bore.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, features and functions of oil grooves.</p> <p>(c) Types, features and functions of oil grooving tools.</p> <p>(d) Methods of oil grooving e.g. freehand and power feeds.</p> <p>(e) Production methods.</p> <p>(f) Calculations for gearing.</p> <p>(g) Operating precautions re high feed hazard.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 6: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>14. Undercutting a bore.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Reasons for undercutting.</p> <p>(c) Types of undercuts.</p> <p>(d) Methods of undercutting.</p> <p>(e) Types and uses of retracting cutter boring bars.</p> <p>(f) Speed and feed for undercutting.</p> <p>(g) Application of lubricants.</p> <p>(h) The freehand method of undercutting.</p> <p>(i) Operating precautions re tool breakage caused by chip build-up.</p>
<p>15. Boring a partial hole.</p> <p>Work held: on the carriage, on the tailstock.</p>	<p>(a) Methods of mounting work, as B1, U2, O6, 8, 10.</p> <p>(b) Types and uses of fly cutters.</p> <p>(c) Methods of blocking a cut-away e.g. plug of same material, etc.</p>
<p>16. Chamfering a bore.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, sizes and uses of internal chamfers.</p> <p>(c) Angle for chamfering.</p> <p>(d) Methods of chamfering a bore.</p> <p>(e) Amount of clearance necessary for forming a chamfer.</p> <p>(f) Type and necessity of lubricant for chamfering.</p> <p>(g) Speed for chamfering operations.</p> <p>(h) Danger of burning the tool e.g. on cast iron.</p> <p>(i) Types and applications of production tools e.g. head on boring bar.</p> <p>(j) Methods of freehand chamfering.</p> <p>(k) Types and features of hand-chamfering tools.</p> <p>(l) Types and features of scrapers for chamfering and de-burring.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Reaming a through parallel hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and features of hand and machine reamers.</p> <p>(c) Reasons for reaming.</p> <p>(d) Methods and theory of reaming.</p> <p>(e) Allowances for reaming.</p> <p>(f) Preparation of bore for reaming.</p> <p>(g) Methods of holding, driving and removing reamers.</p> <p>(h) Types, features and functions of reamer holding devices e.g. floating, adjustable, etc.</p> <p>(i) Types and uses of coolants and lubricants.</p> <p>(j) Methods of applying coolants and lubricants.</p> <p>(k) Cutting speeds and feeds.</p> <p>(l) Types, uses and care of precision hole measuring instruments.</p> <p>(m) Methods of measuring and gauging holes.</p> <p>(n) Methods of measuring and testing reamers.</p> <p>(o) Methods of controlling and correcting chatter e.g. wood slip, rags, etc.</p> <p>(p) Chip disposal and control.</p> <p>(q) Methods of feeding reamers.</p> <p>(r) Selection of reamers e.g. specifications for ordering, factors governing selection, etc.</p> <p>(s) Diagnosis and correction of reamer troubles e.g. excessive wear, bell mouthing, etc.</p> <p>(t) Methods of avoiding distortion e.g. thin-wall work.</p> <p>(u) Specifications accuracy required.</p> <p>(v) Methods of reaming long bores e.g. guide bushings, extensions, etc.</p> <p>(w) Methods of reaming interrupted bores e.g. pilots, spiral reamers, etc.</p> <p>(x) Operating precautions in the use of reamers e.g. starting, dwell, reversing, seizing, etc.</p> <p>(y) Operating precautions re handling and storing reamers.</p> <p>(z) Safety practices re handling e.g. cut nands, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Reaming a through parallel hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, 06, 8, 10.</p> <p>(b) Methods of holding, driving, and feeding reamers.</p> <p>(c) Reaming procedures.</p> <p>(d) Methods of feeding work.</p> <p>(e) Types and uses of combined drills and reamers.</p> <p>(f) Types and uses of line reamers.</p> <p>(g) Safety practices re rotating tools, etc.</p>
<p>3. Reaming a blind parallel hole.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, 02, 3, 7, 9.</p> <p>(b) Types, features and functions of reamers for blind holes e.g. end cutting reamers, rose reamers, etc.</p> <p>(c) Reaming procedures.</p> <p>(d) Allowances in depth for reaming blind holes e.g. amount of starting taper, extra depth, etc.</p> <p>(e) Methods of measuring and gauging depth.</p> <p>(f) Types and applications of depth measuring instruments.</p> <p>(g) Chip control and disposal.</p> <p>(h) Production methods e.g. carriage stops, dial gauges, etc.</p> <p>(i) Types and uses of reamer extensions and guide bushings.</p> <p>(j) Operating precautions re bottoming.</p>
<p>4. Reaming a blind parallel hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, 06, 8, 10.</p> <p>(b) Types and uses of guide bushings.</p> <p>(c) Methods of controlling depth.</p> <p>(d) Methods of applying lubricant e.g. oil feeding reamers; hollow holders, etc.</p> <p>(e) Safety practices.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Reaming a through stepped hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Design and use of stepped holes.</p> <p>(c) Types, features and functions of stepped line-reamers.</p> <p>(d) Reaming procedures.</p> <p>(e) Kinds and application of coolants and lubricants.</p> <p>(f) Kinds and uses of stepped holes.</p> <p>(g) Types and uses of reamer guides and bushings.</p> <p>(h) Chip control and disposal.</p> <p>(i) Operating precautions re chip pile-up.</p>
<p>6. Reaming a through stepped hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Types and uses of piloted reamers.</p> <p>(c) Methods of measuring obstructed stepped holes.</p> <p>(d) Types and uses of inserted cutter reamers.</p> <p>(e) Methods of preventing eccentricity due to weight of reamer heads e.g. intermediate bearings.</p> <p>(f) Methods of mounting and driving reamers.</p>
<p>7. Reaming a blind stepped hole.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Methods of sizing the end-hole e.g. roughing and finishing reamers.</p> <p>(c) Types and uses of reamer guide bushings.</p> <p>(d) Operating precautions re bottoming.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>8. Reaming a blind stepped hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of feeding work.</p>
<p>9. Reaming a through tapered hole.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work, as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, features and functions of tapered reamers e.g. roughing and finishing.</p> <p>(c) Allowance for taper reaming.</p> <p>(d) Methods of testing and gauging tapers.</p> <p>(e) Chip control and disposal.</p> <p>(f) Kinds and uses of tapers.</p> <p>(g) Kinds and uses of standard tapers. Specifications - Handbook tables.</p> <p>(h) Reaming procedures.</p> <p>(i) Speeds and feeds for taper reaming.</p> <p>(j) Methods of taper reaming in alignment.</p> <p>(k) Preparation of a hole for taper reaming.</p> <p>(l) Methods of testing and measuring taper gauges. Maths - formulae.</p> <p>(m) Prevention and correction of chatter e.g. spiral, odd flutes, etc.</p> <p>(n) Operating precautions re grabbing.</p>
<p>10. Reaming a through tapered hole.</p> <p>Work held: on the carriage on the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of feeding work.</p> <p>(c) Methods of guiding and supporting tapered reamers.</p> <p>(d) Methods of reaming tapered split bearings.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>11. Reaming a blind tapered hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Methods of testing and gauging e.g. template.</p> <p>(c) Methods of driving and feeding.</p> <p>(d) Chip control and disposal.</p> <p>(e) Cuttings, speeds and feeds.</p> <p>(f) Need and use of coolants and lubricants.</p> <p>(g) Types and uses of blind tapered holes e.g. center holes, sleeves, etc.</p> <p>(h) Operating precautions re chip-interference.</p> <p>(i) Operating precautions re bottoming.</p> <p>(j) Operating precautions re sticking of gauges.</p>
<p>12. Reaming a blind tapered hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of feeding work.</p> <p>(c) Operating precautions re reamer breakages.</p>
<p>13. Reaming a cored through hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and features of core reamers.</p> <p>(c) Reaming procedures.</p> <p>(d) Speeds and feeds.</p> <p>(e) Types and features of cored holes e.g. die cast, sand cast, etc.</p> <p>(f) Operating precautions re starting.</p> <p>(g) Operating precautions re warped, blow holes, sand, etc.</p>
<p>14. Reaming a cord through hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Reaming procedures.</p> <p>(c) Methods of starting reamers.</p> <p>(d) Methods of truing to cored holes.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 7: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>15. Reaming a cored blind hole.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Reaming procedures.</p> <p>(c) Types of reamers for cored holes.</p> <p>(d) Methods of cleaning castings e.g. sand blasting, pickling, chipping, rumbling, etc.</p> <p>(e) Operating precautions re bottoming.</p>
<p>16. Reaming a cored blind hole.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Reaming procedures.</p>

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Die Cutting a single start, parallel thread.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Terminology and specifications of threads e.g. V-types, modified V, square, special, etc.</p> <p>(c) Types, features and functions of threading dies e.g. solid, adjustable, releasing, etc.</p> <p>(d) Methods of adjusting dies e.g. accurate sizing, re-threading, etc.</p> <p>(e) Reasons for die cutting threads.</p> <p>(f) Types of threads usually die cut.</p> <p>(g) Methods of holding and feeding dies.</p> <p>(h) Uses and limitations of die cut threads.</p> <p>(i) Preparation of work for threading e.g. chamfers, outside diameter, etc.</p> <p>(j) Threading procedures e.g. methods of starting, ending, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (Cont'd.)	<ul style="list-style-type: none"> (k) Calculation of neck-diameters. (l) Types and uses of shoulders. (m) Speeds for threading. (n) Methods of threading to a shoulder e.g. reversing the die, etc. (o) Methods of producing running threads. (p) Types and uses of threading lubricants. (q) Methods of chip control and disposal. (r) Diagnosis and correction of thread troubles e.g. drunken, torn, off size, etc. (s) Methods of measuring, testing and gauging e.g. Micrometer, pitch gauge, ring gauge, etc. (t) Types, uses, and care of thread measuring instruments. (u) Types and uses of re-threading dies. (v) Calculating strength of screw threads. Maths - formulae. (w) Selection of die for material to be cut. (x) Classifications and uses of thread fits. (y) Operating precautions e.g. starting, shouldering, reversing, etc. (z) Safety practices re crushed fingers from wrenches, stocks turning, etc.
2. Die cutting a single start, parallel thread.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O6, 8, 10. (b) Methods of feeding work. (c) Types and uses of all thread rods. (d) Methods of mounting dies e.g. live mounted, reversing, etc. (e) Methods of threading to a shoulder e.g. carriage stops, die-release, etc. (f) Production methods e.g. fixtures, etc. (g) Types and uses of starting guides. (h) Preparation of work for threading e.g. stock sizing to clear guides. (i) Methods of applying coolant for production work. (j) Types of carriage mounted work e.g. eye bolts, crating hooks, etc.
Work held: on the carriage, in the tailstock.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. (Cont'd.)	<ul style="list-style-type: none"> (k) Methods of quality control e.g. half nuts, leaders, etc. (l) Types and features of clamping fixtures and devices.
<p>3. Die cutting a single start tapered thread.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a chuck, on a faceplate, in a steady rest, on centers, on a mandrel, on the spindle nose. 	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9. (b) Types and features of tapered threading dies e.g. solid adjustable, etc. (c) Specifications of tapered threading dies. (d) Reasons for taper threading e.g. pressure fits, etc. (e) Methods of preparing work e.g. taper turning, etc. (f) Methods of adjusting and using taper threading dies. (g) Methods of gauging, testing and measuring taper threads. (h) Methods of preventing off profile threads e.g. leaders, followers, etc. (i) Nomenclature and specifications of standard taper threads. (j) Methods of quality and size control e.g. profile, taper, etc. (k) Care and storage of dies.
<p>4. Die cutting a single start, tapered thread.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the carriage, in the tailstock. 	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O6, 8, 10. (b) Types of taper threaded work e.g. large diameter and long pipes, etc. (c) Types of pipe-gripping devices. (d) Methods of roughing and finishing tapered threads. (e) Methods of chip control and disposal. (f) Speeds for taper threading.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Tapping a single start through parallel thread.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, uses and specifications of standard taps.</p> <p>(c) Methods of holding and supporting taps.</p> <p>(d) Calculations for tap drill sizes.</p> <p>(e) Methods of tapping in alignment.</p> <p>(f) Speeds for tapping.</p> <p>(g) Types and application of lubricants.</p> <p>(h) Methods of starting taps.</p> <p>(i) Methods of gauging, testing and measuring tapped holes e.g. plug gauge.</p> <p>(j) Classification of fits e.g. serial taps, etc.</p> <p>(k) Preparation of work for tapping.</p> <p>(l) Types and uses of releasing tapping chucks.</p> <p>(m) Types and uses of collapsing taps.</p> <p>(n) Types and uses of combination drills and taps.</p> <p>(o) Methods of measuring and testing taps.</p> <p>(p) Nomenclature and specifications of standard taps.</p> <p>(q) Types and features of devices for checking lead.</p> <p>(r) Diagnosis and correction of tapping troubles e.g. dullness, radial relief; etc.</p> <p>(s) Production methods e.g. square turrets, taper taps, etc.</p> <p>(t) Methods of controlling length of thread.</p> <p>(u) Types, application and care of female thread measuring instruments.</p> <p>(v) Selection of tap for material to be cut.</p> <p>(w) Methods and reasons for re-tapping e.g. oversize taps, etc.</p> <p>(x) Operating precautions re bottoming, clogging of taps, etc.</p> <p>(y) Operating precautions re seizing of plug gauges, etc.</p> <p>(z) Operating precautions re using serial taps e.g. sequence of use, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>6. Tapping a single start, through, parallel thread.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of feeding work.</p> <p>(c) Methods of mounting and driving taps e.g. reversing, clutch-type, etc.</p> <p>(d) Types, features and uses of tap holders.</p> <p>(e) Types and uses of shell taps.</p> <p>(f) Types and uses of interrupted thread taps.</p> <p>(g) Types and uses of piloted taps.</p> <p>(h) Production methods e.g. extension shanks, fixtures, collapsing taps, etc.</p> <p>(i) Types and uses of spiral pointed taps e.g. gun taps.</p> <p>(j) Coolant application in production work.</p> <p>(k) Kinds of work requiring carriage mounting e.g. hickies, crow's foot, etc.</p> <p>(l) Horsepower requirements for tapping.</p> <p>(m) Care and storage of taps.</p> <p>(n) Operating precautions re small hole tapping.</p>
<p>7. Tapping a single start, blind, parallel thread.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types, features and uses of bottom taps.</p> <p>(c) Sequence of tapping e.g. taper plug and bottoming.</p> <p>(d) Production methods e.g. extra hole depth, depth gauge, etc.</p> <p>(e) Preparation of work e.g. annular thread relief, counterbore, etc.</p> <p>(f) Chip disposal e.g. plastic plugs, grease, white lead, etc.</p> <p>(g) Requirements of entrance counterbores e.g. tap outside diameter above nominal.</p> <p>(h) Methods of tapping deep holes e.g. counter-bore to clear snank, etc.</p> <p>(i) Operating precautions re bottoming.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>8. Tapping a single start, blind, parallel thread.</p> <p>Work held: on the carriage, on the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, 06, 8. (b) Methods of feeding work to the tap. (c) Tapping procedures. (d) Methods of gauging blind holes e.g. plug gauge air release. (e) Operating precautions re seizing of plug gauges.</p>
<p>9. Tapping a single start, through, tapered thread.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, 3, 7, 9. (b) Types, features and uses of standard and bastard taper taps. (c) Preparation of work for taper tapping e.g. taper boring, reaming, etc. (d) Methods of testing, gauging and measuring internal taper threads e.g. plug gauge, pitch gauge, etc. (e) Depth for taper tapping e.g. size control. (f) Speeds for taper tapping. (g) Types and features of taper thread measuring instruments and gauges. (h) Types and uses of standard taper threads. (i) Calculations for tapers. (j) Methods of holding taps for heavy duty tapping. (k) Procedures for power tapping. (l) Production methods e.g. tap release, etc.</p>
<p>10. Tapping a single start, through, tapered thread.</p> <p>Work held: on the carriage, in the tailstock.</p>	<p>(a) Methods of mounting work as B1, U2, 06, 8. (b) Methods of feeding work or tap. (c) Speeds for taper tapping. (d) Lubricants for tapping. (e) Types of work requiring carriage mounting. (f) Tapping procedures. (g) Methods of relieving carriage drag e.g. use of lead screw, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>11. Tapping a single start, blind, tapered thread.</p> <p>Work held: in a chuck, on a faceplate, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and features of taper taps for blind holes.</p> <p>(c) Methods of controlling depth.</p> <p>(d) Methods of checking and measuring blind taper threads.</p> <p>(e) Preparation of hole for taper tapping e.g. boring, reaming, etc.</p> <p>(f) Operating precautions re bottoming.</p>
<p>12. Tapping a single start, blind, tapered thread.</p> <p>Work held: on the carriage, in the tailstock, on the bed.</p>	<p>(a) Methods of mounting work as B1, U2, O6, 8, 10.</p> <p>(b) Methods of holding and driving taps.</p> <p>(c) Tapping procedures.</p> <p>(d) Power requirements for tapping e.g. back gears, etc.</p>
<p>13. Screw cutting i.e. power chasing a single start, parallel, external thread.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and specifications of threads e.g. Vee, Acme, Square, Buttress, etc.</p> <p>(c) Thread nomenclature and terminology.</p> <p>(d) Types, features and functions of screw cut threads e.g. translating screws, fastenings, etc.</p> <p>(e) Types, features and selection of single and multiple point threading tools.</p> <p>(f) Methods of measuring and gauging threading tools.</p> <p>(g) Types, uses and care of thread measuring instruments e.g. optical comparator, etc.</p> <p>(h) Methods of measuring, checking and gauging screw threads.</p> <p>(i) Threading procedures e.g. optimum in-feed, direction of compound slide, etc.</p> <p>(j) Methods of selecting and setting lead for threading e.g. standard quick change; change gears, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
13. (Cont'd.)	<ul style="list-style-type: none"> (k) Gear Calculations. (l) Speeds for threading. (m) Methods of cutting extra large diameter threads e.g. boring bar, etc. (n) Classification of fits. (o) Gear trains and methods of transmission e.g. terms, etc. (p) Re-threading procedures e.g. picking up thread. (q) Height and position of tools. (r) Effective pitch of lead screw. Math. Ratio, e.g. spindle to stud, etc. (s) Type and uses of thread indicators e.g. chasing dial, etc. (t) Diagnosis and correction of screw cutting errors e.g. off pitch, etc. (u) Methods of cutting quick pitches or fast leads e.g. countershaft method, slow speed attachment, etc. (v) Special tools for long slender work e.g. combined toolholder and follower rest, etc. (w) Methods of testing and checking lead screw accuracy e.g. long range indicator. (x) Effect of off position tool settings e.g. curved sides, off angle, etc. (y) Methods of cutting left hand threads. (z) Types and uses of cross feed stops. (aa) Production methods e.g. multiple tooth circular threading tool. (ab) Types and uses spring threading tool holders. (ac) Methods of setting and adjusting single point circular threading tools. (ad) Methods of cutting odd pitch threads without a chasing dial e.g. marking spindle, lead screws, etc. (ae) Types and features of files for touching-up threads. (af) Methods of filing threads.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>14. Screw cutting a single start, parallel, external thread.</p> <p>Work held: on centers, on a mandrel.</p>	<p>(a) Methods of mounting work as B1, U2, O4, 5.</p> <p>(b) Methods of tailstock alignment e.g. proof bar, etc.</p> <p>(c) Methods of wedging driving dog.</p> <p>(d) Types, features and uses of follower rests for threading.</p> <p>(e) Methods of preparing work for center mounting e.g. slender shafts, tubular, etc.</p> <p>(f) Methods of compensating for lathe wear e.g. extension live center, etc.</p> <p>(f) Methods of returning to start. e.g. reversing machine, rapid traverse, etc.</p> <p>(h) Methods of compensating for starting thrust e.g. deepening starting thread, etc.</p> <p>(i) The vicious circle of heat. Physics - heat expansion.</p> <p>(j) Methods of removing and replacing work e.g. marking driving slot.</p> <p>(k) Methods of measuring and gauging center mounted threads e.g. snap type thread gauges, micrometer, etc.</p> <p>(l) Methods of increasing pitch for shrinkage in heat treatment. Maths-trigonometry.</p> <p>(m) Methods of decreasing pitch for fitting to heat treated work. Maths - gear ratio.</p> <p>(n) Limitations of three wire method of thread measurement.</p> <p>(o) Reasons for and methods of honing tools e.g. for cutting plastic, aluminum, etc.</p> <p>(p) Production methods e.g. box turret, etc.</p> <p>(q) Direction of cut on mandrel mounted work.</p> <p>(r) Layout and threading procedures e.g. spooling screws.</p> <p>(s) Bending effect of lathe dogs, use of compensating plate, etc.</p> <p>(t) Type of work requiring screw cutting.</p> <p>(u) Methods of cutting interrupted threads, e.g. eliminating carriage jump.</p> <p>(v) Methods of adapting English lathes to cut metric threads e.g. translating gear.</p> <p>(w) Operating precautions re cutting mating threads e.g. cut both parts on same lathe.</p> <p>(x) Operating precautions re starting place of carriage, e.g. split threads, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>15. Screw cutting a single start, tapered, external thread.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and uses of tapered threads usually screw cut.</p> <p>(c) Correct position of tool for taper threading e.g. center height and normal to axis.</p> <p>(d) Threading procedures.</p> <p>(e) Exception to the general setting rule e.g. Hughes Thread - normal to taper.</p> <p>(f) Methods used in taper threading e.g. taper attachment, offset tailstock, etc.</p> <p>(g) Freehand methods of tool withdrawal.</p> <p>(h) Methods of measuring and gauging standard taper threads.</p> <p>(i) Preparation of work for taper threading.</p> <p>(j) Speeds for taper threading.</p> <p>(k) Engagement allowance for pipe work e.g. fittings.</p> <p>(l) Operating precautions re backlash in taper attachment.</p>
<p>16. Screw cutting a single start, tapered, external thread.</p> <p>Work held: on centers, on a mandrel.</p>	<p>(a) Methods of mounting work as B1, U2, O4, 5.</p> <p>(b) Errors in setover method e.g. short pitch.</p> <p>(c) Types and uses of center lubricants.</p> <p>(d) Threading procedures.</p> <p>(e) Types and application of coolants and lubricants.</p> <p>(f) Operating precautions re use of hardened mandrel e.g. tool gouging; seizing centers, etc.</p>
<p>17. Screw cutting a single start, parallel, internal thread.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Methods of cutting internal threads.</p> <p>(c) Types and uses of internal threading tools e.g. single and multiple point.</p> <p>(d) Position of threading tools.</p> <p>(e) Direction of tool in-feed for internal threading.</p> <p>(f) Types, features and application of tool-setting gauges.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
17. (Cont'd.)	<ul style="list-style-type: none"> (g) Preparation of work for internal threading. (h) Methods of threading a blind bore. (i) Methods of thread shaving e.g. forming tool, etc. (j) Use of a tap for internal threading e.g. use of tap as chaser in large diameter bores. (k) Relation of boring bar size to bore size. (l) The effect of tool finish on work e.g. gauge making, etc. (m) Methods of honing tools. (n) Precision methods of finishing and sizing threads. (o) Speeds for internal threading. (p) Types and application of coolants. (q) Calculations of bore size. (r) Types, features and care of internal thread measuring instruments and gauges. (s) Types and features of central leaders e.g. special pitches in large diameter bore. (t) Types and uses of piloted threading bars. (u) Types and features of spindle pilot bushings. (v) Methods of analyzing internal thread conditions e.g. wax, plaster, etc. (w) Types and uses of internal thread endings e.g. annular relief; run-out, etc. (x) Methods of finishing a thread start e.g. chamfer, etc. (y) Chip control and disposal e.g. pressure application of cutting lubricant. (z) Methods of keeping bore parallel e.g. brass slip; back slide cut; etc. (aa) Re-threading procedures. (ab) Calculation of throats and counterbores. (ac) In-feed control e.g. cross slide stops, etc. (ad) Production methods e.g. roughing and finishing tools; toolpost; turrets; stops; etc. (ae) Methods of cutting interrupted threads e.g. elimination of carriage jumps; tool hogging, etc. (af) Operating precautions re seizing of gauges. (ag) Operating precautions re tool overhang. Physics - resonance. (ah) Operating precautions re bottoming. (ai) Operating precautions re tool clearance in small bores e.g. heel, bar angle, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
17. (Cont'd.)	(aj) Operating precautions re disengaging half nuts i.e. in center of bore; etc.
18. Screw cutting a single start, parallel, internal thread. Work held: on a mandrel, on centers.	(a) Methods of mounting work as B1, U2, O4, 5. (b) Types of work requiring mandrel and center mounting. (c) Types of tools for internal threading e.g. offset bars, etc. (d) Methods of eliminating tool spring e.g. mandrel rest. (e) Methods of testing and gauging obstructed bores, e.g. hollow gauges, etc. (f) Methods of driving large diameter work on a mandrel e.g. double-dogged; keyed; etc. (g) Methods of preventing chatter. (h) Methods of supporting thin webbed work e.g. flanged mandrels. (i) Operating precautions re use of mandrels e.g. bending, centers wearing.
19. Screw cutting a single start, tapered, internal thread. Work held: in a chuck, on a faceplate, in a steady rest, in the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Preparation of work for cutting tapered threads. (c) Methods of setting tools. (d) Methods of cutting internal tapered threads. (e) Methods of in-feeding tools. (f) Methods of testing and gauging internal tapered threads. (g) Design and features of internal tapered threads. (h) Operating precautions re bottoming.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 8: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>20. Screwcutting a multiple start, parallel, external thread.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Types, features and uses of multiple threads e.g. rapid traverse screws, etc.</p> <p>(c) Types, design and selection of single point threading tools.</p> <p>(d) Methods of holding threading tools for high helix angle e.g. canted tool holders, etc.</p> <p>(e) Calculations for threading tool templates.</p> <p>(f) Methods of measuring and gauging threading tools.</p> <p>(g) Methods of grinding and sharpening tool bits.</p> <p>(h) Calculation for gearing.</p> <p>(i) Methods of indexing work.</p> <p>(j) Types and features of indexing devices.</p> <p>(k) Calculations for spacing on the bed e.g. starting points.</p> <p>(l) Preparation of work for threading.</p> <p>(m) Methods of cutting fast leads.</p> <p>(n) Types and uses of slow speed attachments.</p> <p>(o) Methods of measuring and checking multiple threads e.g. lead pitch diameter, etc.</p> <p>(p) Production methods e.g. multiple point tools.</p> <p>(q) Methods of setting and checking multiple point tools.</p> <p>(r) Limitations of multiple point threading tools e.g. shoulder work.</p> <p>(s) Operating precautions re tool clearance.</p>
<p>21. Screw cutting multiple start, parallel, internal thread.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Preparation of work for multiple threading.</p> <p>(c) Types and features of internal threading tools.</p> <p>(d) Methods of mounting boring tools.</p> <p>(e) Cutting speeds for internal multiple threading.</p> <p>(f) Calculations for required r.p.m.</p> <p>(g) Types and uses of piloted bars.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 9: KNURLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Knurling parallel surface.</p> <p>Work held: in a chuck, on a faceplate, on a mandrel, on centers, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Reasons for knurling e.g. grips ornamentation, fits, etc.</p> <p>(c) Types, features and functions of knurling tools e.g. turret, hand and plain, etc.</p> <p>(d) Speeds and feeds for knurling.</p> <p>(e) Lubricants.</p> <p>(f) Selection of knurls e.g. pattern, grade, etc.</p> <p>(g) Knurling procedures e.g. pressure, etc.</p> <p>(h) Diagnosis and correction of knurling troubles.</p> <p>(i) Types and application of knurl patterns e.g. diamond, helical, straight, etc.</p> <p>(j) Diameter increase.</p> <p>(k) Basic principles of knurling e.g. plastic deformation of materials. Metallurgy.</p> <p>(l) Operating precautions re splitting, smearing, bending, etc.</p> <p>(m) Safety practices re fingers, rags, etc.</p>
<p>2. Knurling a bevel.</p> <p>Work held: in a chuck, on a faceplate, on a mandrel, on centers, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Methods of feeding knurls e.g. compound slide, plunge cut, etc.</p> <p>(c) Methods of stopping knurl-head rotation e.g. use of single knurl.</p> <p>(d) Reasons for bevel knurling.</p> <p>(e) Types of bevel knurls.</p>
<p>3. Knurling concave or convex surfaces.</p> <p>Work held: in a chuck, on a faceplate, on a mandrel, on centers, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Types and applications of contour knurls.</p> <p>(c) Methods of in-feeding knurls e.g. correct depth, timing, etc.</p> <p>(d) Operating precautions re hand tools e.g. gathering, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 9: KNURLING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Knurling a face. Work held: in a chuck, on a faceplate, on a mandrel, on centers, in a steady rest, on the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9. (b) Types and applications of face knurls. (c) Speeds and feeds for face knurling. (d) Knurling procedures. (e) Calculating feeds for face knurling.
5. Knurling a parallel bore. Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Reasons for internal knurling e.g. repair work, expansion, etc. (c) Types and applications of internal knurls. (d) Knurling procedures. (e) Types and uses of piloted knurls. (f) Operating precautions re knurling e.g. cast iron, crumbling, etc. (g) Operating precautions re distortion e.g. internal pressure on thin walled castings.

BLOCK I: ENGINE LATHE PRACTICE

UNIT 10: FILING AND POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Filing a parallel and/or tapered surface. Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.	(a) Methods of mounting work as B1, U2, O2, 3, 5, 7, 9. (b) Types, features and specifications of files used in lathe work. (c) Kinds of work requiring filing. (d) Allowances for filing. (e) Filing procedures e.g. methods of holding, etc. (f) Speeds for filing e.g. file stroke and spindle. (g) Methods of filing, wet and dry. (h) Lubricants used when filing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 10: FILING AND POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (Cont'd.)	<ul style="list-style-type: none"> (i) Methods of protecting lathe e.g. way shields, etc. (j) Methods of filing to a shoulder e.g. file shields, safe edge, etc. (k) Methods of cleaning files. (l) Types and uses of file cards and pin tools. (m) Types and designs of file handles. (n) Methods of attaching file handles. (o) Diagnosis and correction of file troubles. (p) Care and storage of files. (q) Surface finishes obtainable. (r) Filing interrupted surface e.g. key way, etc. (s) Methods of plugging a gap e.g. key way, etc. (t) Operating precautions re filing flat. (u) Safety practices e.g. use of file handles, loose clothing, hitting chuck jaws, etc.
2. Filing a groove and/or neck. Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work, as B1, U2, O2, 3, 4, 5, 7, 9. (b) Procedures in filing grooves and necks. (c) Types and features of safe face files. (d) Operating precautions re file breakage e.g. binding in groove, etc.
3. Filing a contour and/or sphere. Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9. (b) Types and features of files for contour work. (c) Speeds for contour filing. (d) Procedures for contour filing. (e) Methods of testing contours. (f) Surface finish obtainable. (g) Reasons for filing contours. (h) Operating precautions re handling work being filed e.g. grease, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 10: FILING AND POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Hand polishing an external surface.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Types, features and classifications of abrasives for polishing e.g. cloths, paste, etc.</p> <p>(c) Methods of mounting and holding abrasive cloths and papers.</p> <p>(d) Types and features of polishing devices e.g. sticks, clamps, pads, etc.</p> <p>(e) Speeds for wet and dry polishing.</p> <p>(f) Methods of applying pressure.</p> <p>(g) Methods of cutting down e.g. rapid traverse.</p> <p>(h) Types and features of polished surfaces.</p> <p>(i) Methods of testing and measuring surface finishes.</p> <p>(j) Types, features and applications of steel wool.</p> <p>(k) The effect of oil on abrasive cloth when polishing.</p> <p>(l) Methods of face polishing.</p> <p>(m) Methods of polishing contours.</p> <p>(n) Reasons for polishing.</p> <p>(o) Types of work requiring polishing.</p> <p>(p) Methods of applying lubricants.</p> <p>(q) Types and features of lubricants for polishing.</p> <p>(r) Allowances for polishing.</p> <p>(s) Types and features of instruments for measuring surface finish.</p> <p>(t) Classification of surface finishes.</p> <p>(u) Polishing speeds.</p> <p>(v) Methods of tearing and cutting abrasive cloth e.g. direction.</p> <p>(w) Methods of holding shapes.</p> <p>(x) Operating precautions re seized centers. Physics-vicious circle of heat.</p> <p>(y) Operating precautions re rounded corners.</p> <p>(z) Operating precautions re discolouring with heat.</p> <p>(aa) Safety practices re pinched fingers.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 10: FILING AND POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Hand polishing an internal surface.</p> <p>Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 7, 9.</p> <p>(b) Types and features of internal polishing sticks.</p> <p>(c) Methods of holding internal polishing devices.</p> <p>(d) Methods of mounting and holding abrasive sticks.</p> <p>(e) Methods of polishing a blind hole bottom.</p> <p>(f) Methods of polishing a trepanned groove.</p> <p>(g) Methods of polishing an angular bore.</p> <p>(h) Methods of polishing a contoured and/or spherical bore.</p> <p>(i) Polishing procedures e.g. holding shape, etc.</p> <p>(j) Types and features of contoured polishing sticks.</p> <p>(k) Speeds for internal polishing.</p> <p>(l) Special methods required for deep holes.</p> <p>(m) Methods of checking and testing deep holes.</p> <p>(n) Operating precautions in polishing a tapered bore re wedging.</p> <p>(o) Safety practices re holding cloth by hand.</p>

BLOCK I: ENGINE LATHE PRACTICE

UNIT 11: ROLLING AND BURNISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Burnishing parallel surface.</p> <p>Work held: in a chuck, on a faceplate, on centers, on a mandrel, in the steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 7, 9.</p> <p>(b) Types of work requiring burnished surface.</p> <p>(c) Types and features of burnishing tools.</p> <p>(d) Speeds and feeds for burnishing e.g. power or hand.</p> <p>(e) Factors governing speeds.</p> <p>(f) Types of finish obtainable by burnishing.</p> <p>(g) Types and characteristics of materials used for burnishing tools.</p> <p>(h) Types and characteristics of materials suitable for burnishing.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE UNIT 11: ROLLING AND BURNISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. (Cont'd.)	<ul style="list-style-type: none"> (i) Types and applications of lubricants for burnishing. (j) Theory of burnishing e.g. plastic deformation. (k) Methods of dressing burnishing tools. (l) Operation precautions re wiping.

BLOCK I: ENGINE LATHE PRACTICE UNIT 12: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Removing broken tools such as drills, taps, burnt centers, etc. Work held: in a chuck, on a faceplate, in a steady rest, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 7, 9. (b) Types of picks and tweezers. (c) Types and features of screw and tap extractors. (d) Methods of annealing work. (e) Features and uses of fish-tail cutters and cutter mills. (f) Types and features of trepanning tools. (g) Types and features of plug cutters. (h) Applications of the electric arc. (i) Methods of protecting work and machine from arc splatter and spotting. (j) Diagnosis and cause of tool breakage. (k) Types and applications of penetrating fluids e.g. water, oil, etc. (l) Methods of applying heat. (m) Advisability of removing broken piece e.g. cost, etc. (n) Methods of using cutting torch. (o) Methods, uses and application of acids. (p) Methods of salvaging work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 12: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Lapping internal, external or flat surfaces.	(a) Methods of mounting as B1, U2, O2, 3, 4, 5, 7, 9, and by hand.
Work held:	(b) The theory of lapping.
in a chuck,	(c) Types, features and functions of laps e.g. male, female, flat.
on a faceplate,	(d) Materials suitable for laps.
on centers,	(e) Types of work requiring lapping.
on a mandrel,	(f) Types and features of abrasives used in lapping compounds.
in a steady rest,	(g) Types of prepared lapping compounds e.g. soluble, etc.
on the spindle nose,	(h) Preparation of work for lapping.
by hand.	(i) Speed for lapping.
	(j) Methods of charging laps.
	(k) Amount of material that can be removed by lapping.
	(l) Allowances for lapping.
	(m) Types and features of lapping lubricants.
	(n) Methods of applying lubricants.
	(o) Methods of adjusting laps.
	(p) Methods of cleaning laps and lapped work e.g. vapour, degreaser, etc.
	(q) Types and features of solvents and cleaning solutions.
	(r) Methods of obtaining broken pattern e.g. reciprocating lap.
	(s) Methods of lapping to a shoulder.
	(t) Methods of lapping a face.
	(u) Types and features of face lapping blocks.
	(v) Diagnosis and correction of lapping troubles.
	(w) Accuracy and finish obtainable.
	(x) Types, uses and care of precision measuring tools.
	(y) Types and features of tapered laps.
	(z) Pressures required in lapping.
	(aa) Methods of holding and driving laps.
	(ab) Methods of maintaining accuracy.
	(ac) Selection of abrasive for lapping.
	(ad) Methods of dressing laps.
	(ae) Time required for lapping.
	(af) Recognition of worn and loaded laps.
	(ag) Methods of protecting machine from abrasive.
	(ah) Grading systems for lapping compounds.
	(ai) Types and features of disc laps.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 12: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
2. (Cont'd.)	<ul style="list-style-type: none"> (aj) Types and uses of work usually disc lapped e.g. snap gauges, etc. (ak) Care and storage of laps. (al) Speeds and feeds for diamond laps. (am) Principles involved in diamond laps. (an) Operating precautions re gauging. (ao) Operating precautions re seizing of gauges. (ap) Operating precautions re barrelling and bell-mouthing. (aq) Operating precautions re starting laps e.g. seizing. (ar) Operating precautions re clamping gauges for lapping. (as) Operating precautions re truing disc laps.
3. Winding a coil.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 9. (b) Methods of holding and driving coil forms and mandrels. (c) Types and features of coil forms. (d) Types and features of wire feeding tools. (e) Methods of controlling wire tension. (f) Methods of layer winding coils. (g) Methods of spacing wire e.g. cord, etc. (h) Speeds for coil winding. (i) Methods of counting turns. (j) Methods of applying insulation between layers. (k) Types and features of insulating material e.g. paper, varnishes, etc. (l) Calculations for turns in windings. (m) Methods of measuring wire size. (n) Methods of splicing wire. (o) Types and features of soldering devices. (p) Methods of insulating wire splices. (q) Types and features of revolution counters. (r) Materials suitable for coils. (s) Methods of testing coils for continuity by use of voltmeter, megger, etc. (t) Types and features of hollow mandrels and cores.
Work held: in a chuck, on a faceplate, on centers, on a mandrel, on the spindle nose.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 12: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
3. (Cont'd.)	<ul style="list-style-type: none"> (u) Methods of starting and finishing coil windings. (v) Methods of taking off taps. (w) Types and features of spooling controls. (x) Coil terminology. (y) Methods of removing coils from mandrels. (z) Methods of mounting stock spools.
4. Winding a spring.	
Work held: in a chuck, on a faceplate, on centers, on a mandrel, on the spindle nose.	<ul style="list-style-type: none"> (a) Methods of mounting as B1, U2, O2, 3, 4, 5, and 9. (b) Types, features and functions of coil springs e.g. tension, compression, and torsion. (c) Types and features of spring winding mandrels. (d) Methods of holding wire when starting winding. (e) Types and features of materials suitable for springs. (f) Spring terminology e.g. lead, etc. (g) Methods of obtaining lead. (h) Methods of controlling tension. (i) Calculations for springs e.g. tension, compression, etc. (j) Allowances in mandrel size and tension for spring back. (k) Methods of finishing spring ends. (l) Spring winding speeds. (m) Methods of holding and driving spring mandrels. (n) Methods of releasing tension of springs. (o) Methods of controlling spring length and number of turns. (p) Spring winding procedures. (q) Methods of cutting springs. (r) Methods of making and cutting retaining clips e.g. circlips, etc. (s) Operating precautions re releasing tension.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK I: ENGINE LATHE PRACTICE

UNIT 12: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Graduating surfaces.</p> <p>Work held: in a chuck, on a faceplate, on a mandrel, on centers, in a steady rest, on the spindle nose.</p>	<p>(a) Methods of mounting work as B1, U2, O2, 3, 4, 5, 9.</p> <p>(b) Types, features and uses of graduated work.</p> <p>(c) Methods of graduating e.g. degrees, English and Metric measurements, etc.</p> <p>(d) Methods of translating English to Metric measurements.</p> <p>(e) Methods of holding and driving graduating tools e.g. fixed stylus, rotary stylus, etc.</p> <p>(f) Graduating procedures.</p> <p>(g) Methods of angular indexing.</p> <p>(h) Methods of longitudinal indexing.</p> <p>(i) Gear calculations for indexing.</p> <p>(j) Methods of controlling length of graduating marks.</p> <p>(k) Design and features of graduating tools.</p> <p>(l) Methods of rotating work e.g. by hand, power, etc.</p>
<p>6. Graduating surfaces.</p> <p>Work held on the carriage.</p>	<p>(a) Methods of mounting work as B1, U2, O6.</p> <p>(b) Types of work requiring carriage mounting.</p> <p>(c) Methods of mounting graduating tools e.g. rotary, fly cutters, etc.</p> <p>(d) Types and features of fly cutters for graduating.</p> <p>(e) Speeds for fly cutting and rotary stylus.</p> <p>(f) Methods of controlling travel e.g. cross-feed stops, clips, etc.</p> <p>(g) Graduating procedures.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK II (A) -- SHAPER PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	60
Unit 2. Working Holding Techniques.....	62
Unit 3. Horizontal Flat Surfacing Techniques.....	65
Unit 4. Vertical Flat Surfacing Techniques.....	67
Unit 5. Angular Flat Surfacing Techniques.....	68
Unit 6. Grooving Techniques.....	71
Unit 7. Forming Techniques.....	73
Unit 8. Contouring Techniques.....	75
Unit 9. Miscellaneous Techniques.....	76

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	<ul style="list-style-type: none">(a) Names and functions of machine parts.(b) Kinds, uses and selection of lubricants.(c) Types and features of lubricating equipment e.g. pressure, drip feed, etc.(d) Statistical control of lubrication e.g. schedule charts, etc.(e) Precaution re over lubricating e.g. motors, etc.(f) Maintenance of automatic lubricating systems.(g) Precautions re replacing lost oil cup caps, dust plugs, etc.(h) Safety practices re power off while oiling machine.
2. Controlling the machine	<ul style="list-style-type: none">(a) Types, features and functions of primary controls e.g. power, clutch, etc.(b) Features and functions of ram controls.(c) Features and functions of feed controls.(d) Features and functions of rapid traverse controls.(e) Use of "inching" switches.(f) Calculation of ram speeds. Maths-formulae.(g) Precaution re clearance of vise from ram before starting.(h) Precaution re reading manual and instruction cards.(i) Safety practices re hands, head and loose clothing.(j) Precaution re tightening clamps before operating ram.(k) Operating procedures.(l) Safety practices re clearing of handles before using rapid traverse.
3. Cleaning the machine	<ul style="list-style-type: none">(a) Types and features of cleaning solvents and materials.(b) Cleaning schedules.(c) Effects of cleaning solvents left on moving parts.(d) Precaution re use of air hose.(e) Precaution re use of caustic cleaners.(f) Safety practices re cleaning chips from "T" Slots e.g. no fingers.(g) Safety practices re locking switch.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
4. Adjusting the machine	<ul style="list-style-type: none"> (a) Methods of adjusting moving parts e.g. table, clapper box, etc. (b) Methods of compensating for wear. (c) Responsibilities of the operator re cleaning, lubricating, adjusting, etc. (d) Procedures and equipment for checking the machine. (e) Recognition and diagnosis of excess wear. (f) Methods of testing and adjusting "clutch drag". (g) Fundamentals of moving parts. (h) Precaution re overtightening of ram gibs.
5. Handling and mounting the following accessories: Vises Fixtures Angle plates Clamping devices Auxiliary tables e.g.: magnetic	<ul style="list-style-type: none"> (a) Types, features and functions of standard accessories. (b) Handling and mounting of the accessories. (c) Care, storage and lubrication of accessories. (d) Methods of checking and testing mounted accessories for truth. (e) Precautions re cleanliness of mating parts. (f) Types and features of lifting equipment.

BLOCK II(A): SHAPER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work	<ul style="list-style-type: none"> (a) Types and features of holding equipment for various types of jobs e.g. vises, clamps, etc. (b) Accuracy required. (c) Rigidity required in set-up. (d) Quantity of parts to be machined. (e) Shape and size of work pieces. (f) Types and jigs and fixtures for odd shaped work. (g) Work piece material e.g. for magnetic chucks, etc.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Setting up work in a vise	<ul style="list-style-type: none"> (a) Types, features and limitations of vises e.g. sine, swivel, etc. (b) Care and storage of vises. (c) Types and features of vise jaws e.g. plain, stepped, etc. (d) Types, features and functions of parallels, solid and adjustable. (e) Methods of protecting work in the vise e.g. copper facings. (f) Equipment used for truing e.g. feelers dial indicators. (g) Use of paper to prevent slippage. (h) Use of bedding pieces for rough castings, etc. (i) Types of material for "bedding" pieces e.g. aluminum, copper, etc. (j) Methods of preventing work rocking in the vise. (k) Types, features and functions of hammers used for "bedding down" work. (l) Precaution re rapping work too hard when bedding down. (m) Tension required for "bedding" and cutting. (n) Methods of checking and correcting levelling errors. (o) Methods of setting up to layouts. (p) Methods of supporting long stock e.g. with jacks, braces, etc. (q) Precautions re removing chips and burrs from work and vise when clamping. (r) Methods of holding tapered or irregular work e.g. swivel jaws, packing blocks, etc. (s) Methods of testing and truing vise jaws. (t) Types, features and functions of air and hydraulic chucks. (u) Tools and instruments used in testing and truing vise jaws. (v) Direction of cut e.g. against fixed jaw if possible. (w) Use of hold downs e.g. toe dogs, hacksaw blades, etc. (x) Use of "V" blocks. (y) Types and features of odd shaped vise jaws e.g. formed, angular, taper, etc. (z) Use of equalizing bar for truing up work to solid jaw. (aa) Reasons for selecting vise for work hold in.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Setting up work on the table	<ul style="list-style-type: none">(a) Types, features and functions of standard clamping devices e.g. plain, "V", finger, etc.(b) Types and features of shaper tables e.g. plain, universal, etc.(c) Methods of adjusting and locking tables.(d) Types and features of "T" slots.(e) Types and features of "T" slot bolts.(f) Types and features of jacks, braces, etc.(g) Types and uses of parallels.(h) Principles of clamping. Physics-Mechanics.(i) Use of anti-slip pieces e.g. paper, etc.(j) Types, features and functions of stop pins, plates, etc.(k) Types, features and functions of aligning strips and bars.(l) Types, features and functions of V-blocks.(m) Types, features and functions of clamps e.g. clamps, toolmaker clamps, etc.(n) Methods of prefacing work for holding on the table.(o) Methods of compensating for inaccurate machines.(p) Methods of clamping and supporting long work.(q) Types, features and functions of packing and step blocks.(r) Reasons for setting up work on the table.
4. Setting up work on the angle plate	<ul style="list-style-type: none">(a) Types and features of standard angle plates.(b) Type of work requiring angle plate mounting.(c) Care and storage of angle plates.(d) Methods of holding work on angle plates e.g. clamps, etc.(e) Methods of obtaining precise angles e.g. sine bars, gauge blocks, etc.(f) Methods of testing and truing angle plates.(g) Methods of clamping angle plates to the table.(h) Set up procedures for internal work.(i) Precautions re distortion when using clamps, parallels, etc.(j) Methods of supporting overhang e.g. with jacks, shims, etc.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	(k) Use of stops, strips, etc. (l) Use of aligning strips. (m) Methods of "cleaning and preparing" surfaces.

BLOCK II(A): SHAPER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Shaping a horizontal, external flat surface Work held In the vise On the table On an angle plate On an auxiliary table On a fixture On the saddle	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Shaper tool design for various materials e.g. finish and roughing. (c) Types of tool holders used on shapers. (d) Methods of mounting tools and tool holders. (e) Selection of cutting speeds and feeds. (f) Calculation of cutting speeds and feeds. (g) Types and uses of measuring instruments for flatness and thickness. (h) Types of surface finishes obtainable, on various materials, in the shaper. (i) Methods of chip control and disposal. (j) Feeds used for roughing and finish cuts. (k) Calculation of time for machining flat surfaces. (l) Maximum cut obtainable for various jobs. (m) Methods of over-coming and preventing chatter. (n) Precaution re setting of feed for direction of cut. (o) Accessories used for relieving carbide tipped tools on return stroke. (p) Layout techniques for shaping. (q) Reasons for bevelling edges on cast iron work. (r) Reasons for "snagging" castings. (s) Precaution re tool holder angle e.g. for holder slippage. (t) Types and uses of feeler gauges (re setting cut). (u) Methods of testing faced surfaces. (v) Precaution re distorting work with work holding method.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (w) Precaution re checking work holding method before starting cut. (x) Principles of dial reading re depth of cut. (y) Quality of finish obtainable. (z) Adjustment of clapper box for shaping to a shoulder. (aa) Types of cutting oils for various materials. (ab) Application of cutting oils. (ac) Recognition of worn cutting tools. (ad) Reasons for first roughing work all over e.g. warpage, etc. (ae) Methods of controlling warped work when remounting. (af) Precaution re stopping tool in the cut. (ag) Methods of removing broken tool bit tip from work e.g. chipping, etc. (ah) Methods of overcoming "diamonds" or hard spots e.g. chiseling, annealing, etc.
2. Shaping a horizontal, external flat surface	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U3, O8. (b) Types of work requiring mounting on base. (c) Methods of feeding tool.
Work held on the base	<ul style="list-style-type: none"> (d) Maximum width that may be shaped. (e) Methods of preventing chatter e.g. "bolsters", etc. (f) Capacity of job size for various shapers.
3. Shaping a horizontal, internal flat surface	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.
Work held In the vise On the table On an angle plate On an auxiliary table On a fixture On the saddle	<ul style="list-style-type: none"> (b) Methods of mounting tools for internal work. (c) Reasons for locking clapper box on internal work. (d) Tool design. (e) Methods of testing and checking internal surfaces. (f) Quality of finish obtainable. (g) Maximum cut e.g. for chatter. (h) Precaution re feeds in confined areas. (i) Precaution re application of cutting oils on internal work.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Shaping a horizontal, external, recessed flat surface.</p> <p>Work held</p> <ul style="list-style-type: none"> In the vise On the table On an angle plate On an auxiliary table On a fixture On the saddle 	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Methods of adjusting stroke. (c) Tool design for recessed work. (d) Methods of relieving chip "built up" at end of stroke. (e) Precaution re checking stroke length and position clamps before starting cut. (f) Methods of chip disposal. (g) Use of dial for calculation of depth. (h) Methods of measuring and checking recessed surfaces. (i) Uses of shaped recessed surfaces.
<p>5. Shaping a horizontal, internal recessed, flat surface.</p> <p>Work held</p> <ul style="list-style-type: none"> in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle 	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Methods of adjusting stroke. (c) Tools and equipment used for checking internal work e.g. mirrors, etc. (d) Tool design. (e) Chip disposal on internal surfaces. (f) Safety practices re getting between ram and job.
<p>6. Shaping a horizontal, undercut flat surface.</p> <p>Work held</p> <ul style="list-style-type: none"> in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle 	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Types of tool holders adaptable to undercut surfaces. (c) Methods of handling clapper box. (d) Design of solid tools. (e) Type of work with undercut flat surfaces e.g. hold down slides, etc. (f) Methods of checking and testing undercuts. (g) Surface finish obtainable.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE UNIT 4: VERTICAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Shaping a vertical, external, flat surface</p> <p>Work held in a vise on a table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Tool design for vertical shaping.</p> <p>(c) Methods of testing the tool head for truth.</p> <p>(d) Principles of the clapper box.</p> <p>(e) The use of the table elevating screw for vertical feeds.</p> <p>(f) Techniques in setting straight and offset tool holders.</p> <p>(g) Calculation of cutting speeds. Maths-formulae.</p> <p>(h) Selection of feeds for various materials e.g. for roughing and finishing cuts.</p> <p>(i) Precaution re clearance of work holding fixture from cut.</p> <p>(j) Precaution re position of tool head on long vertical surfaces e.g. clearance.</p> <p>(k) Precaution re bowed work e.g. vise pressure, improper clamping, etc.</p> <p>(l) Types and application of cutting compounds.</p> <p>(m) Production methods.</p> <p>(n) Calculation of cutting time.</p> <p>(o) Methods of testing and measuring vertical faces.</p> <p>(p) Surface finish obtainable.</p> <p>(q) Procedures in vertical shaping to a shoulder.</p>
<p>2. Shaping a vertical, internal, flat surface.</p> <p>Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Types of tool holders for vertical, internal work.</p> <p>(c) Types and design of cutting tools.</p> <p>(d) Methods of cutting to a shoulder.</p> <p>(e) Methods of preventing clapper box lifting during cut e.g. lever, etc.</p> <p>(f) Visual aids for internal work e.g. mirrors, lighting, etc.</p> <p>(g) Methods of applying coolants.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 5: ANGULAR FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Shaping an external, angular, flat surface	(a) Methods of holding work as B3, U2, O2, 3, 4, 5, 6, 7.
Work held	(b) Types, features and uses of angular work.
in a vise	(c) Methods of cutting short, angular work e.g. fixed tools, etc.
on the table	(d) Equipment used for cutting angles e.g. sine vises, fixtures, etc.
on an angle plate	(e) Features and functions of degree parallels.
on an auxiliary table	(f) Methods of truing work to a layout.
on a fixture	(g) Calculation of angles.
on the saddle	(h) Methods of reading the graduations on the swivel blocks.
	(i) Production methods.
	(j) Tool design for roughing and finishing.
	(k) Precaution re tool head hitting column when swiveled.
	(l) Methods of checking and testing angular work.
	(m) Tools and equipment used for checking and testing angular work.
	(n) Methods of checking the swivel head setting for precision angles.
	(o) Roughing and finishing tools for various materials.
	(p) Clapper box setting for angular work.
	(q) Tool setting for angular work.
	(r) Procedures for shaping V-grooves.
	(s) Principles of the vernier protractor.
	(t) Cutting compounds used for various materials.
	(u) Application of cutting compounds.
	(v) Care and protection of fine finishes.
	(w) Methods of removing burrs.
	(x) Use of combined feeds for angle cuts.
	(y) Calculation for combined feeds.
	(z) Setups for compound tapers.
	(aa) Applications for compound tapers e.g. gibs, etc.
	(ab) Methods used for roughing (by hand feed, etc.).

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 5: ANGULAR FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Shaping an internal, angular, flat surface</p> <p>Work held in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Types of internal angular work machined on a shaper.</p> <p>(c) Precautions re interrupted cuts.</p> <p>(d) Calculations for angles for hexagons, octagons, etc.</p> <p>(e) Methods of making starting holes for shaping internally e.g. burning, drilling, coring, etc.</p> <p>(f) Methods of mounting tools for internal work.</p> <p>(g) Types and features of testing and measuring tools.</p> <p>(h) Uses for internal angular work e.g. wrenches, bearing seats, etc.</p> <p>(i) Precaution re end clearance in blind bores.</p> <p>(j) Methods of working to a layout e.g. splitting pockmarks, etc.</p>
<p>3. Shaping an external undercut, angular, flat surface.</p> <p>Work held in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Tool design for solid and high speed tool bits.</p> <p>(c) Tools used for undercutting.</p> <p>(d) Types, features and functions of undercut angular flat surface e.g. dovetail slides, etc.</p> <p>(e) Measuring and testing equipment for undercut angles.</p> <p>(f) Methods of measuring and checking dovetails e.g. measuring over pin, templates, etc.</p> <p>(g) Calculation for measuring and testing.</p> <p>(h) Procedures for cutting dovetails.</p> <p>(i) Reasons for leaving a fillet in the corners.</p> <p>(j) Standards for dovetails.</p> <p>(k) Tolerances obtainable on a shaper.</p> <p>(l) Tolerance and surface finish as required by job specifications.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 5: ANGULAR FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Shaping an internal, undercut, angular, flat surface.	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.
Work held	(b) Tool setups for internal, angular work.
in a vise	(c) Uses of internal, angular work e.g. dovetail keyways, etc.
on the table	(d) Measuring and testing equipment.
on an angle plate	(e) Methods of measuring and testing.
on an auxiliary table	(f) Precaution re clapper box slippage.
on a fixture	(g) Effect of a fixed clapper box on the tool.
on the saddle	(h) Precaution re timing of feed with a locked clapper box.
	(i) Reasons for locking clapper box on undercut angular work e.g. overhead work.

BLOCK II(A): SHAPER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Shaping a plain groove in an external horizontal surface.	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.
Work held	(b) Types and uses of grooves e.g. keyways, etc.
in the vise	(c) Types and designs of grooving and parting tools.
on the table	(d) Layout techniques.
on an angle plate	(e) Testing and measuring tools and equipment.
on an auxiliary table	(f) Techniques for truing to layout.
on a fixture	(g) Diagnosis and correction of chatter.
on the saddle	(h) Types, features and functions of cutting oils.
	(i) Diagnosis and correction of tool breakage.
	(j) Methods of measuring depth.
	(k) Methods of relieving ends for blind grooves, e.g. feather keyways.
	(l) Ram setting procedures for blind grooves.
	(m) Chip disposal for blind grooves.
	(n) Precaution re clapper box and swivel head settings.
	(o) Types and standards for various keyways.
	(p) Types and uses of multiple tool holders.
	(q) Methods of setting tools in multiple tool holders.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (r) Speeds and feeds used for grooving. (s) Grooving procedures. (t) Surface finish obtainable. (u) Calculating time for grooving. (v) Operating precautions re care of machine and accessories e.g. tools, toolholders, attachments, etc. (w) Safety practices (re tools, fingers, etc.). (x) Diagnosis and correction of tool breakage e.g. feed, chips packing, etc. (y) Principles of spring tools for finishing cuts.
2. Shaping a plain groove in an internal, horizontal surface	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Methods of mounting tools. (c) Principles of tool setting e.g. amount of overhang, etc. (d) Keyway standards for internal work. (e) Types and design of internal cutting tools. (f) Principles of forging, hardening, and tempering tool steel. (g) Types of hard faced tools e.g. carbide, stellite, etc. (h) Uses of internal plain grooves e.g. keyways, etc. (i) Precaution re tool digging in at each end of the stroke. (j) Methods of correcting tool spring. (k) Tool holding methods for internal work. (l) Methods of drilling holes in internal work for blind grooves. (m) Chip disposal for internal work. (n) Application of coolants. (o) Safety practices re clearance between ram and work.
Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle	

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Shaping a plain groove in an external, vertical surface,</p> <p>Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Types of tools and tool holders suitable for grooving on vertical faces.</p> <p>(c) Precaution re forgetting to clamp clapper box.</p> <p>(d) When to use a loose or clamped clapper box.</p> <p>(e) Precaution re lengthening stroke with a loose clapper box and tool clearing accessories.</p> <p>(f) Accessories used for clearing the tool from the job, with a loose clapper box e.g. hinged plate, a piece of leather, etc.</p> <p>(g) Precaution re clearance for ram on deep cuts.</p> <p>(h) Diagnosis and correction of external grooving troubles.</p> <p>(i) Production methods.</p> <p>(j) Types and features of auxiliary clapper boxes.</p>
<p>4. Cutting a plain groove in an internal, vertical surface.</p> <p>Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Types and features of tool holders for vertical internal faces.</p> <p>(c) Precaution re interrupted cuts.</p> <p>(d) Diagnosis and correction of internal grooving troubles.</p> <p>(e) Methods of positioning the tool.</p>
<p>5. Shaping a plain groove in an external, angular surface.</p> <p>Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.</p> <p>(b) Types, features and uses of grooved angular work.</p> <p>(c) Methods of squaring tools from angular surfaces.</p> <p>(d) Types and uses of multiple tool holders.</p> <p>(e) Kinds and selection of single point tool holders.</p> <p>(f) Methods of fitting and testing with the male counterpart.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Cont'd.	(g) Equipment used for truing machined angular faces for grooving e.g. dial indicators, feeler gauges, etc.
6. Shaping a plain groove in an internal, angular surface. Work held in the vise on the table on an angle plate on an auxiliary table on a fixture on the saddle	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Selection of feeds and speeds for grooving e.g. by charts, calculation or performance. (c) Specifications e.g. accuracy required. (d) Features and functions of auxiliary clapper boxes. (e) Methods of cleaning castings e.g. sand blasting, chipping, etc.
7. Cutting a plain groove in an undercut surface. Work held in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Tool design for grooving undercut surfaces. (c) Application of lubricants. (d) Methods of measuring and inspecting obstructed grooves. (e) Types and uses of ball gauges and small hole gauges. (f) Make shift measuring equipment in shop e.g. key stock, etc.

BLOCK II(A): SHAPER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Shaping an external curved surface. Work held in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle	(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Methods of grinding forming tools for curved surfaces e.g. offhand, tool grinder, etc. (c) Methods of checking forming tools. (d) Preparation of work for forming. (e) Methods of measuring and inspecting curved surfaces e.g. templates, shadowgraphs, etc.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none">(f) Care and storage of template.(g) Diagnosis and correction of chatter.(h) Types, features and functions of cutting oils.(i) Surface finish obtainable.(j) Methods used for setting forming tools.(k) Selection of speeds and feeds for forming.(l) Tool design for various materials.(m) Uses for an external curved surface.(n) Feeds and speeds for forming.(o) Production methods.(p) Condition of the machine e.g. capacity to take wide cuts.(q) Method of using combination automatic horizontal and hand vertical feeds for roughing cuts.(r) Techniques for forging solid forming tools.(s) Principles of hardening and tempering.(t) Application of coolants and lubricants for external work.
2. Shaping an internal, curved surface.	<ul style="list-style-type: none">(a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7.(b) Methods of mounting internal forming tools.(c) Uses for internal curved surfaces.(d) Procedures for roughing internal work.(e) Coolants and lubricants for various materials.(f) Preparation of work for forming to a blind end.(g) Speeds and feeds for internal work.(h) Application of coolants and lubricants to internal work.(i) Features and functions of fillets and radii.(j) Techniques for preventing chatter on large fillets and radii.
Work held in a vise on a table on an angle plate on an auxiliary table on a fixture on the saddle	

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Cutting a ratchet.</p> <p>Work held</p> <ul style="list-style-type: none"> in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle 	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Types, features and uses of linear ratchets. (c) Ratchet nomenclature. (d) Tool design for roughing and finishing cuts. (e) Safety stress for various materials. (f) Cutting speeds and feeds. (g) Methods of repositioning tool in a cut e.g. replacing toolbit. (h) Methods of finishing ratchets e.g. deburring, etc. (i) Surface finish required. (j) Setting of shaper for undercut teeth e.g. swivel head, clapper-box, etc.

BLOCK II(A): SHAPER PRACTICE

UNIT 8: CONTOURING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Shaping a contour on an external surface.</p> <p>Work held</p> <ul style="list-style-type: none"> in a vise on the table on an angle plate on an auxiliary table on a fixture on the saddle 	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Uses for external contoured surfaces. (c) Tool design for contouring work. (d) Techniques for roughing out work. (e) Types, features and principles of automatic contouring devices. (f) Types and features of templates. (g) Care and storage of templates. (h) Methods of testing and measuring external contoured surfaces e.g. templates, shadowgraphs, etc. (i) Care and storage of testing and measuring equipment. (j) Techniques for using hand vertical feeds and automatic horizontal feeds at the same time. (k) Diagnosis and correction of contouring troubles e.g. faulty setups, etc. (l) Calculation of cutting speeds and feeds. (m) Preparation of work e.g. chipping castings, snagging, etc.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 8: CONTOURING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (n) Cutting oils and coolants used for various materials. (o) Methods of picking up cut e.g. replacing tool bit. (p) Allowance for finishing cuts. (q) Principles of spring finishing tools. (r) Calculation of machining time. Maths - formulae. (s) Setting of the clapper box for contouring.
2. Shaping a contour on an internal surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Uses for internal contoured surfaces. (c) Methods used in testing and measuring internal contoured surfaces. (d) Layout procedures for contoured work. (e) Surface finish obtainable. (f) Chip control and disposal. (g) Application of coolants. (h) Precautions re interrupted cuts. (i) Tool setups for blind bores. (j) Specifications e.g. accuracy required. (k) Production methods. (l) Methods of testing surface finish.
Work held	
in a vise	
on the table	
on an angle plate	
on an auxiliary table	
on a fixture	
on the saddle	

BLOCK II(A): SHAPER PRACTICE

UNIT 9: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Knurling a flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, O2, 3, 4, 5, 6, 7. (b) Uses for knurled surfaces. (c) Types and features of knurling tools. (d) Types and application of various knurl patterns e.g. diamond, straight, etc. (e) Lubricants used for knurling. (f) Application of lubricant. (g) Speeds and feeds for knurling. (h) Principles of knurling. (i) Preparation of work for knurling.
Work held	
in a vise	
on the table	
on an angle plate	
on an auxiliary table	
on a fixture	
on the saddle	

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(A): SHAPER PRACTICE

UNIT 9: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (j) Calculation for surface height increase. (k) Diagnosis and correction of knurling troubles. (l) Procedures in knurling e.g. pressure starting procedures. etc. (m) Methods of stopping knurl head rotation e.g. lock pins, etc. (n) Precaution re distortion on thin sectioned castings. (o) Precautions re splitting, smearing, etc. (p) Safety practices re fingers, rays, etc. (q) Production methods. (r) Finish obtainable. (s) Depth and appearance of a finished knurl.
2. Serrating a flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B3, U2, 02, 3, 4, 5, 6. (b) Reasons for serrating work. (c) Tool design for various serrations. (d) Types and design of serrations e.g. diamond, square, etc. (e) Preparation of work for serrating. (f) Calculation for feeds. (g) Methods of starting feed for second cut. (h) Speeds for serrating. (i) Principles of dial reading for depth of cut. (j) Graduate reading for offsetting the vise. (k) Setting work to a layout e.g. work mounted on table, angle plate, etc. (l) Coolants and lubricants used. (m) Tool life for various materials using high speed steels, carbide tools, etc. (n) Calculation of machining time. (o) Finish obtainable. (p) Diagnosis and correction of serrating troubles. (q) Accessories for lifting carbide tipped tools on the return stroke. (r) Methods of resetting a tool to a partially completed surface. (s) Methods of removing broken tool bit tips from work e.g. chipping, etc.
Work held in a vise on the table on an angle plate on an auxiliary table on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK II (B) - SLOTTER PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	79
Unit 2. Work Holding Techniques.....	81
Unit 3. Flat Surfacing Techniques.....	83
Unit 4. Grooving Techniques.....	84
Unit 5. Forming Techniques.....	86

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	<ul style="list-style-type: none">(a) Names and functions of machine parts.(b) Principles of machine lubrication.(c) Types and features of lubricating equipment e.g. pressure, drip feed, etc.(d) Statistical control of lubrication by schedule charts, etc.(e) Precaution re over lubricating e.g. motors, etc.(f) Adjustments and maintenance of automatic lubricating systems.(g) Kinds, uses and selection of lubricants.(h) Care and storage of lubricants e.g. coloured oil cans, dirt tight receptacles, etc.(i) Precautions re replacing lost and damaged oil cup caps, dust plugs, etc.(j) Safety practices re power off while oiling the machine.(k) Safety practices re removal of oil and grease from the floor.(l) Reasons for overheated bearings, seizure, etc.
2. Controlling the machine	<ul style="list-style-type: none">(a) Types, features and functions of the primary controls.(b) Location of the switches and clutches.(c) Precaution re releasing all clutches before starting the motor.(d) Use of inching switches.(e) Methods of adjusting the ram speeds.(f) Procedure in setting the length and position of the stroke.(g) Precaution re clearance for the ram before starting the machine.(h) Precaution re reading manual and instruction cards.(i) Operating procedures.(j) Safety practices re hands, loose clothing, head, etc.(k) Precaution re bumping rapid traverse.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
3. Cleaning the machine	<ul style="list-style-type: none">(a) Types and features of cleaning solvents and materials.(b) Methods of removing rust.(c) Cleaning schedules.(d) Reasons for cleaning.(e) Effect of cleaning solvents left on moving parts.(f) Precaution re use of air hose.(g) Precaution re use of caustic cleaners.(h) Safety practices re cleaning chips from T-slots e.g. no fingers.(i) Safety practices re locking the switch.
4. Adjusting the machine	<ul style="list-style-type: none">(a) Methods of adjusting moving parts e.g. table, apron, etc.(b) Methods of compensating for wear.(c) Diagnosis and correction of excess wear.(d) Allowable tolerance for moving parts.(e) Procedures and equipment for checking the machine.(f) Responsibility of the operator e.g. clean, lubricate, adjust, etc.(g) Methods of cleaning grease and oil off belts.(h) Expected performance from moving parts.(i) Precaution re overtightening of ram gibs.(j) Selection and handling of tools for adjustment e.g. spanners, sockets, screw drivers, etc.
5. Handling and mounting the following accessories: clamping devices angle plates vises fixtures	<ul style="list-style-type: none">(a) Types, features and functions of standard accessories.(b) Methods of locating position for accessories.(c) Methods of checking and testing mounted accessories for truth.(d) Use of paper for friction.(e) Precaution re cleanliness of mating parts.(f) Types and features of lifting equipment.(g) Care, storage and lubrication of accessories.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work	<ul style="list-style-type: none"> (a) Types and features of holding equipment available for various types of jobs. (b) Amount of material to be removed e.g. light or heavy cuts. (c) Hardness of material e.g. clamp marks, bending, etc. (d) Accuracy required. (e) Quantity of parts to be machined. (f) Shape and size of work pieces. (g) Types of fixtures and jigs for odd shaped work.
2. Setting up work on the table	<ul style="list-style-type: none"> (a) Types and design of parallel blocks or strips. (b) Selection of parallels e.g. for tool clearance. (c) Care and storage of parallels. (d) Make shift parallels e.g. key stock, etc. (e) Types, features and functions of clamping devices e.g. plain, V, finger, etc. (f) Holding capacity of clamps. (g) Design, uses of application of T slots. (h) Types and features of T slot bolts and washers. (i) Basic design and functions of slotter tables. (j) Principles of clamping. Physics--mechanics. (k) Use of anti-slip pieces e.g. paper, etc. (l) Types of materials suitable for shimming work. (m) Location of clamps and parallels e.g. clamps over parallels. (n) Production methods e.g. stops, etc. (o) Methods of preparing work for clamping on table e.g. snagging, etc. (p) Types, features and functions of packing and step blocks. (q) Reasons for setting up work on the table. (r) Diagnosis and correction of setup errors. (s) Methods of locating work e.g. from the centre or edge of table. (t) Types, features and use of tools for locating work.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (u) Methods of compensating for inaccurate machines. (v) Types, features and functions of V-blocks. (w) Methods of clamping and supporting long work e.g. outboard slides, etc. (x) Types, features and use of soft faced hammers. (y) Set up techniques for table mounted work. (z) Types, features and uses of wedges. (aa) Lifting equipment for heavy work. (ab) Techniques for slinging work. (ac) Methods of stacking work.
3. Setting up work on the angle plate	<ul style="list-style-type: none"> (a) Types and features of standard angle plates. (b) Care and storage of angle plates. (c) Preliminary examination of angle plate e.g. for burrs, etc. (d) Type of work mounted on angle plates bearing blocks, etc. (e) Tools and equipment for obtaining precise angles e.g. sine bars, gauge blocks, etc. (f) Use of stops, strips, etc. (g) Methods of locating the position for the angle plate. (h) Methods of holding work to an angle plate e.g. C-clamps, bolting, finger clamps, etc. (i) Methods of supporting overhang e.g. jacks, shims, etc. (j) Set up methods for production work. (k) Precaution re distortion when using clamps, parallels, etc. (l) Methods of testing and truing angle plates. (m) Tolerance for the setup.
4. Setting up work on jigs and fixtures	<ul style="list-style-type: none"> (a) Types, features and functions of jigs and fixtures. (b) Methods of mounting jigs and fixtures. (c) Methods of centring the table before attaching fixture e.g. for key seating. (d) Care and storage of fixtures. (e) Scope of work machined on fixtures. (f) Application of various jigs and fixtures.

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 3: FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Cutting an external, flat surface.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4. (b) Slotter tool design for various kinds of materials. (c) Tool mounting procedures. (d) Surface finish obtainable on a slotter. (e) Adjustment of the stroke and speeds. (f) Feeds for roughing and finishing cuts. (g) Chip control and disposal. (h) Application and control of cutting oils. (i) Recognition of worn cutting tools. (j) Precaution re checking of stacked work for shifting. (k) Methods and techniques for working to a layout. (l) Precaution re loose table. (m) Amount of material left for finishing cuts. (n) Precaution re stopping tool in cut. (o) Principles of dial reading. (p) Calculations for dial reading. (q) Calculation of machining time.</p>
<p>2. Cutting an internal, flat surface.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4. (b) Preparation of work prior to slotting e.g. drilling, etc. (c) Tool design suitable for slotting. (d) Methods of lining up table to layout. (e) Precaution re clearance of parallels from cut. (f) Application of cutting oil. (g) Methods of cutting to and around corners. (h) Diagnosis and correction of tool breakage e.g. dull tool, clearance, etc. (i) Methods of stopping pieces being cut out from dropping e.g. spacers under it, wedges in slots, etc. (j) Precaution re wedges loosening. (k) Methods of removing centre sections. (l) Tools suitable for cornering and radiusing. (m) Speeds and feeds for slotting. (n) Precaution re backlash when dial reading. (o) Chip control and disposal.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 3: FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Cutting a recessed flat surface.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4.</p> <p>(b) Preparation of work for machining e.g. grooving, etc.</p> <p>(c) Tools suitable for recessing.</p> <p>(d) Methods of relieving chip at the end of stroke.</p> <p>(e) Uses for recessed, machined surfaces.</p> <p>(f) Measuring and testing tools for recessed surfaces.</p> <p>(g) Procedures for recessing.</p> <p>(h) Speeds and feeds.</p> <p>(i) Application of lubricants and coolants.</p> <p>(j) Diagnosis and correction of surface finish troubles.</p> <p>(k) Tools and equipment for checking internal work e.g. mirrors, lighting, etc.</p>

BLOCK II(B): SLOTTER PRACTICE

UNIT 4: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Cutting a plain, external groove.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4.</p> <p>(b) Uses for plain, external grooves.</p> <p>(c) Tool design for external grooving.</p> <p>(d) Methods of centring and truing work.</p> <p>(e) Tool mounting procedures.</p> <p>(f) Adjustment of the stroke and speeds.</p> <p>(g) Tools used for testing and measuring slots.</p> <p>(h) Procedures in cutting a slot.</p> <p>(i) Techniques for working to a layout.</p> <p>(j) Principles of dial reading.</p> <p>(k) Types and application of coolants.</p> <p>(l) Surface finish obtainable.</p> <p>(m) Calculation for dial reading.</p> <p>(n) Chip control and disposal.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 4: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Cutting a plain, internal groove.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4.</p> <p>(b) Uses for internal grooves e.g. keyways, etc.</p> <p>(c) Standards for keyways.</p> <p>(d) Methods of truing to a layout.</p> <p>(e) Calculation for measuring tapered keyways.</p> <p>(f) Methods of centring table.</p> <p>(g) Reasons for re-checking the work after clamping.</p> <p>(h) Location of keyways e.g. opposite centre of a spoke.</p> <p>(i) Diagnosis and correction of bar spring e.g. dull tool, too heavy a feed, etc.</p>
<p>3. Cutting a dovetail groove.</p> <p>Work held on the table on an angle plate on jigs and fixtures</p>	<p>(a) Methods of mounting work as B3, U2, O2, 3, 4.</p> <p>(b) Uses for dovetail slots e.g. keyways, etc.</p> <p>(c) Methods of roughing out dovetails.</p> <p>(d) Tool design for roughing and finishing.</p> <p>(e) Procedures for machining dovetails.</p> <p>(f) Tool design for undercutting.</p> <p>(g) Allowances for finishing cuts.</p> <p>(h) Methods of testing and measuring.</p> <p>(i) Tolerance allowable.</p> <p>(j) Speeds and feeds for machining.</p> <p>(k) Layout procedures.</p> <p>(l) Effects of sharp corners e.g. weakening, etc.</p>

AN ANALYSIS OF THE MACHINISTS TRADE

BLOCK II(B): SLOTTER PRACTICE

UNIT 5: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cutting an external, formed surface.	(a) Methods of mounting work as B3, U2, O2, 3, 4.
Work held on the table on an angle plate on jigs and fixtures	(b) Types and selection of forming tools. (c) Methods of checking forming tools. (d) Preparation of work for forming. (e) Scope of formed surface e.g. maximum width per cut. (f) Speeds and feeds for forming. (g) Types, features and selection of cutting tools. (h) Diagnosis and correction of forming troubles. (i) Production methods. (j) Procedures for forming. (k) Finish obtainable. (l) Measuring and inspection tools e.g. templates, etc. (m) Care and storage of forming tools. (n) Protection and handling of finished work.
2. Cutting an internal formed surface.	(a) Methods of mounting work as B3, U2, O2, 3, 4.
Work held on the table on an angle plate on jigs and fixtures	(b) Tools for internal forming. (c) Uses for internal formed surfaces. (d) Application of coolants and lubricants to internal work. (e) Features and functions of fillets and radii. (f) Speeds and feeds for internal work. (g) Methods of measuring and inspecting internal forms.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III - BENCHWORK PRACTICE

TABLE OF CONTENTS		PAGE
Unit 1.	The Layout Table.....	88
Unit 2.	Work Mounting Techniques.....	89
Unit 3.	Surface Preparation Techniques.....	91
Unit 4.	Basic Layout Techniques.....	93
Unit 5.	Precision Layout Techniques.....	97
Unit 6.	Miscellaneous Layout Techniques.....	98
Unit 7.	The Work Bench.....	100
Unit 8.	Work Holding Techniques.....	101
Unit 9.	Hammering Techniques.....	102
Unit 10.	Hand Sawing Techniques.....	103
Unit 11.	Chipping Techniques.....	105
Unit 12.	Filing Techniques.....	107
Unit 13.	Scraping Techniques.....	111
Unit 14.	Shearing Techniques.....	113
Unit 15.	Forming and Bending Techniques.....	118
Unit 16.	Drilling Techniques.....	120
Unit 17.	Reaming Techniques.....	122
Unit 18.	Tapping Techniques.....	124
Unit 19.	Threading Techniques.....	126
Unit 20.	Riveting Techniques.....	127
Unit 21.	Grinding-Offhand.....	128
Unit 22.	Polishing Techniques.....	129
Unit 23.	Lapping Techniques.....	130
Unit 24.	Belt Fastening Techniques.....	131
Unit 25.	Arbor Press Techniques.....	132
Unit 26.	Soft Soldering Techniques.....	133
Unit 27.	Babbitting Techniques.....	135
Unit 28.	Fitting and Assembling Techniques.....	136
Unit 29.	Measuring, Testing and Inspecting Techniques...	138

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK

UNIT 1: THE LAYOUT TABLE

OPERATIONS	KNOWLEDGE
1. Selecting the layout table	<ul style="list-style-type: none">(a) Factors governing the selection e.g. size of work, shape of work, etc.(b) Types, features and applications of layout tables e.g. bench type, floor type, etc.(c) The recommended height of layout tables.(d) Advantages of revolving layout plates.(e) The required accuracy of the layout operation.(f) Layout practice in production plants, jobbing shops, etc.
2. Installing the layout table	<ul style="list-style-type: none">(a) The nature and scope of work to be performed.(b) The amount and kind of lighting required.(c) The accessibility of a power supply.(d) Types and features of foundations for heavy duty work.(e) Methods of levelling a layout table and/or surface plate.(f) Methods of testing and truing surface plates and/or tables.(g) Types, features and construction of "floor pits".(h) Types, features and uses of "shims".
3. Maintaining the layout table	<ul style="list-style-type: none">(a) Methods of removing corrosion.(b) The use, care and storage of chemicals and cleaners. Chemistry.(c) Types, features and uses of abrasives.(d) Types, uses and care of levelling and testing equipment e.g. levels, straight edges, etc.(e) Types and features of hand scrapers.(f) Methods of corrosion prevention.(g) Methods of re-surfacing tables and surface plates.(h) The effect of temperature on large plates or tables. Physics.(i) Types and features of files and file handles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK

UNIT 1: THE LAYOUT TABLE

OPERATIONS	KNOWLEDGE
<p>4. Handling and mounting layout table accessories, such as:</p> <p>parallels (plain, box, adjustable)</p> <p>Angle plates (solid, angular, adjustable)</p> <p>Bench centers</p> <p>Magnetic chucks</p> <p>V-blocks</p> <p>Step blocks</p> <p>Bench plates, etc.</p>	<p>(a) Methods of handling, mounting and storing accessories.</p> <p>(b) Types, features and uses of lifting equipment e.g. crane, lift truck, etc.</p> <p>(c) Methods of attaching accessories to table (when necessary).</p> <p>(d) Inspection and care of "aligning tongues" and "table grooves".</p> <p>(e) Types, features and applications of layout accessories.</p> <p>(f) Types, features and uses of de-magnetizing equipment.</p>
<p>5. Selecting and using auxiliary devices, such as:</p> <p>Screw jacks</p> <p>Wedges</p> <p>Levelling plates (screw type)</p> <p>Shim stock, etc.</p>	<p>(a) Type of work requiring mounting.</p> <p>(b) Methods of preventing slippage e.g. paper, jigs, etc.</p> <p>(c) Methods of cutting shim stock.</p> <p>(d) Types, features and applications of auxiliary devices.</p>

BLOCK III: BENCHWORK

UNIT 2: WORK MOUNTING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Selecting the method of mounting</p>	<p>(a) The type of layout required.</p> <p>(b) The size and characteristics of the work-piece.</p> <p>(c) The types, features and applications of lifting equipment.</p> <p>(d) Methods of holding and supporting frail work.</p> <p>(e) The quantity of parts involved.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK

UNIT 2: WORK MOUNTING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Setting up work on parallels	<ul style="list-style-type: none"> (a) Types, features and uses of parallels. (b) Methods of testing and truing parallels. (c) Methods of securing work. (d) Care in handling precision parts. (e) Safety precautions e.g. work slippage, flying sand on castings, etc. (f) Methods of work identification e.g. tags, etc.
3. Setting up work on angle plates such as: solid plates, "off-angle" plates, adjustable angle plates	<ul style="list-style-type: none"> (a) Types, features and uses of angle plates. (b) Methods of setting and testing angles. (c) Types, features and applications of precision instruments e.g. height gauge, dial indicator, etc. (d) Types, features and methods of using sine bars and gauge blocks. (e) Calculations of angles and functions. (f) The types and uses of mathematical tables. (g) How to determine the "reference point".
4. Setting up work on bench centers	<ul style="list-style-type: none"> (a) Preparation of work for center mounting. (b) Methods of driving center-mounted work. (c) Types, features and methods of using drivers and dogs. (d) Calculations for indexing. (e) Methods of inspecting and cleaning "center holes". (f) Precautions re damaging centers e.g. "staking" center hole, etc. (g) Methods of protecting finished parts e.g. copper under dog, etc.
5. Setting up work on a magnetic chuck	<ul style="list-style-type: none"> (a) Types of work usually mounted on magnetic chucks e.g. small precision parts, etc. (b) Methods of "de-magnetizing" heat-treated parts e.g. tools, etc. (c) Types and features of magnetic chuck accessories, as: "V" blocks, parallels, angle plates, etc. (d) Precaution re using dial indicators e.g. magnetism.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK

UNIT 2: WORK MOUNTING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Setting up work on "V" blocks	<ul style="list-style-type: none"> (a) Types, features and applications of "V" blocks e.g. solid, adjustable, etc. (b) Methods of protecting finished parts e.g. copper "V" liners, etc. (c) Methods used in precision work e.g. "matched" blocks, etc. (d) Types, features and uses of clamping devices.
7. Setting up work on bench plates	<ul style="list-style-type: none"> (a) Types, features and uses of bench plates. (b) Care in handling and storing precision plates. (c) Precautions re burrs on work or plate. (d) Types and uses of small clamping devices e.g. toolmaker's clamps, etc. (e) Methods of testing surface plates. (f) Methods of adjusting work e.g. shims, cigarette papers, etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 3: SURFACE PREPARATION TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Preparing rolled steel for layout, such as: bar, sheet, plate, etc.	<ul style="list-style-type: none"> (a) Factors governing the preparation such as: accuracy required, quantity of parts, size of work, etc. (b) Methods of removing "scale". (c) Surface coatings for: Hot rolled, de-scaled, cold rolled steel, etc. (d) The durability of coatings. (e) Precautions re filing "mill scale" e.g. dull file, etc. (f) Need for layout materials chalk, whiting dyes, etc.
2. Preparing a machined surface for layout	<ul style="list-style-type: none"> (a) Types, features and characteristics of layout fluids. (b) Methods of degreasing work. (c) Precautions re excess acid e.g. copper sulphate.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 3: SURFACE PREPARATION TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none">(d) Precautions re use of carbon tetrachloride e.g. deadly fumes, etc.(e) Methods of applying surface preparations e.g. brush, waste, etc.(f) Precautions re use of acid solutions e.g. never pour water into acid.(g) Preparation and use of aniline dye solutions.
3. Preparing a rough casting or forging for layout	<ul style="list-style-type: none">(a) Factors governing the preparation such as: size of work, condition of surface, etc.(b) Methods of offhand grinding.(c) Types, features and methods of using portable grinders.(d) The advantages of alcohol in a whiting solution.(e) Types and features of commercial preparations.(f) Methods of determining area to be painted e.g. preliminary layout.(g) Preparation of work for layout.(h) Preparation and use of whiting solutions, chalk, etc.
4. Preparing non-ferrous metals for layout	<ul style="list-style-type: none">(a) Types and features of preparations for non-ferrous materials.(b) Methods of cleaning non-ferrous castings.(c) Types and uses of electro-chemical cleaning equipment.(d) Types, features and applications of "bright-dipping" solutions.(e) Safety precautions re acid fumes.(f) Types and features of rotary wire brushes.(g) Methods of removing layout fluid e.g. solvent required, etc.(h) Methods of acid and solvent disposal e.g. avoid damage to plumbing.(i) Safety practices - re use of acids--eyes, clothes, skin, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 3: SURFACE PREPARATION TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Preparing non-metallic materials for layout	<ul style="list-style-type: none"> (a) The effect of layout fluid on work material e.g. phenolic-resin plastics. (b) Colors of layout fluid available. (c) Interpretation of "Departmental Color Codes" e.g. in production work. (d) The durability of the coating. (e) Methods of removing coating from non-metallic materials.

BLOCK III: BENCHWORK - LAYOUT PRACTICE

UNIT 4: BASIC LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the Basic Reference Point, Line, Edge or Surface	<ul style="list-style-type: none"> (a) Blueprint reading and interpretation of specifications. (b) Factors governing the selection, such as: kind of layout tools available, kind of layout to be done, size and shape of work, etc. (c) Subsequent machining operations. (d) Procedures in machine tool operation. (e) Reason for obtaining reference points. (f) Necessity for knowing sequence of machine operations. (g) Need for using sharp tools and instruments. (h) Methods of sharpening tools. (i) Methods of making permanent layouts e.g. prick punching.
2. Laying out a straight line, parallel to a flat surface	<ul style="list-style-type: none"> (a) Methods of drawing a line parallel to a flat surface. (b) Types, features and applications of layout tools. (c) Methods of setting a surface gauge. (d) Methods of holding a steel rule perpendicular. (e) Precautions re "Parallax". (f) Methods of "folding" a surface gauge for storage. (g) Types, features and applications of the "combination square".

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK - LAYOUT PRACTICE UNIT 4: BASIC LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd	(h) Care, use and storage of layout tools. (i) Precautions re use of worn rules. (j) Layout procedures. (k) Safety practices - sharp point on scribe of surface gauge.
3. Laying out a straight line parallel to a straight edge	(a) Methods of drawing a line parallel to a straight edge. (b) Types and features of layout tools for drawing parallel lines. (c) How to sharpen and adjust scribing tools such as hermaphrodites, surface gauge, marking gauge, etc. (d) Principles of geometric construction. (e) Safety practices - re use of sharp pointed tools. (f) Precautions re holding hermaphrodite calipers correctly on work. (g) Layout procedures.
4. Laying out a straight line perpendicular to a flat surface	(a) Methods of erecting perpendiculars. (b) Types and features of precision layout tools such as: try square, angle plates, surface gauges, etc. (c) Types, features and uses of scribes. (d) Procedures in maintaining and sharpening scribing tools. (e) Types, features and uses of measuring instruments. (f) Layout procedures.
5. Laying out a straight line perpendicular to a straight edge	(a) Types, features and functions of tools used, such as: gauges, squares, straight edges, etc. (b) Methods of testing squares. (c) Correct method of scribing lines. (d) Layout procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK - LAYOUT PRACTICE UNIT 4: BASIC LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>6. Laying out a straight line at an angle to:</p> <p>a straight edge</p> <p>a horizontal flat surface</p> <p>a vertical flat surface</p> <p>an angular flat surface</p>	<p>(a) Types, features and applications of angle measuring tools e.g. bevel protractor, plain bevel, etc.</p> <p>(b) Types, features and uses of templates.</p> <p>(c) Principles of mathematics.</p> <p>(d) Types, features and applications of the "sine bar".</p> <p>(e) Types, features and uses of precision gauge blocks.</p> <p>(f) Calculations for angular measurements.</p> <p>(g) The types and uses of machinists tables.</p> <p>(h) Layout procedures.</p> <p>(i) Types, features and functions of vernier instruments.</p>
<p>7. Laying out a line, equidistant from a contoured edge or surface</p>	<p>(a) Types, features and applications of tools used e.g. hermaphrodites, scribing blocks, height gauges, etc.</p> <p>(b) Methods of drawing arcs and circles.</p> <p>(c) Methods of locating arc centers.</p> <p>(d) Principles of "permanent layout".</p> <p>(e) Principles of geometry.</p> <p>(f) Layout procedures.</p>
<p>8. Laying out an arc or circle on a flat surface:</p> <p>on solid material from a hole</p>	<p>(a) Methods of establishing center points.</p> <p>(b) Types, features and uses of center punches.</p> <p>(c) Types, features and uses of circle marking tools, such as: dividers, trammels, etc.</p> <p>(d) Types and features of "hole bridges".</p> <p>(e) Methods of setting dividers, trammels, etc.</p> <p>(f) Types, features and functions of divider balls.</p> <p>(g) Layout procedures.</p>
<p>9. Laying out geometric Shapes, as:</p> <p>regular</p> <p>irregular</p>	<p>(a) Rudiments of drafting e.g. geometric construction, triangulation.</p> <p>(b) Geometric propositions.</p> <p>(c) Layout procedures.</p> <p>(d) Types and features of "construction aids" e.g. templates, discs, etc.</p> <p>(e) Types, features and uses of "bench centers".</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK - LAYOUT PRACTICE UNIT 4: BASIC LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
10. Laying out centers on cylindrical work	<ul style="list-style-type: none"> (a) Methods of mounting work. (b) Types, features and application of levelling instruments. (c) Methods of locating and marking centers. (d) Types, features and care of instruments used. (e) Methods of checking for "truth". (f) Methods of "shifting" center location e.g. "staking", "scraping", etc. (g) Layout procedures.
11. Laying out centers on irregular work	<ul style="list-style-type: none"> (a) Methods of mounting and holding work. (b) Methods of locating center of gravity. Science - mechanics. (c) Methods of measuring offset e.g. for an eccentric, etc. (d) Methods of "proving" center location. (e) Types of work requiring layout e.g. con-rod forgings, etc. (f) Layout procedures.
12. Subdividing the circumference of a circle: on a flat surface on the periphery of a cylinder	<ul style="list-style-type: none"> (a) Methods of supporting work. (b) Factors governing the layout procedure e.g. size of work, accuracy required, etc. (c) Methods of locating the "reference point". (d) Calculation of angles and chords. (e) Techniques of the trial and error method e.g. reduction of error, etc. (f) Methods of using the "dividing head". (g) The type of division required e.g. equal spacing, angular, increment. (h) Layout procedures.
13. Subdividing a straight line, as: regular irregular	<ul style="list-style-type: none"> (a) Principles of linear measurements. (b) Methods of subdividing a line. (c) Types, features and applications of measuring instruments. (d) Methods of transferring measurements. (e) Precautions re "parallax". (f) The use of the "diagonal scale". (g) The correct use and care of measuring and marking instruments. (h) Layout procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK - LAYOUT PRACTICE UNIT 4: BASIC LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
14. Laying out for drilling a round hole as: on a flat surface on the periphery of a cylinder on a cone, etc.	(a) Methods of determining the center point. (b) Procedures in describing arcs and circles. (c) The use of "checking circles". (d) The purpose of "witness marks". (e) Procedures in "permanent layout". (f) Elements of blueprint reading. (g) Methods of locating and laying out a circle on the surface of a cylinder.

BLOCK III: BENCHWORK PRACTICE

UNIT 5: PRECISION LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Laying out accurately spaced holes in a straight line	(a) Methods of setting dividers. e.g. to a vernier, etc. (b) Types, features and uses of "vernier calipers". (c) Types, features and functions of "toolmakers buttons". (d) How to drill and tap a parallel hole. (e) Types, features and functions of straight edges. (f) Methods of spacing "buttons". (g) Types and features of "spacers". (h) Types, features and uses of "toolmakers microscopes". (i) The ring method of button spacing.
2. Laying out accurately spaced holes on a circle	(a) Methods of subdividing a circle. (b) Methods of fitting a "center plug". (c) Methods of spacing "toolmakers buttons" on a circle. (d) Calculation of "spacer pieces". (e) Types, features and uses of "micrometer calipers". (f) How to read a micrometer. (g) The use of "discs" and "rings" in setting buttons.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 5: PRECISION LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Laying out an accurate angle	<ul style="list-style-type: none"> (a) Calculations of triangles. (b) Types, features and methods of using "vernier protractors". (c) Types and applications of sine bars. (d) Methods of setting plain bevels e.g. the layout method. (e) Types and uses of precision gauge blocks. (f) How to use a vernier height gauge. (g) Methods of testing and measuring angles.
4. Laying out accurate hole locations	<ul style="list-style-type: none"> (a) The co-ordinate method of hole location. (b) How to use a Machinist's Handbook e.g. tables, etc. (c) Types, features and methods of using "dial indicators". (d) Methods of testing hole locations. (e) Types, features and uses of depth micrometers. (f) Types and uses of feelers e.g. shim stock, cigarette papers. (g) Care in selection of the reference point, edge or surface.

BLOCK III: BENCHWORK PRACTICE

UNIT 6: MISCELLANEOUS LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Laying out to a template, such as: an outline hole location a reference line or point, etc.	<ul style="list-style-type: none"> (a) Types, features and uses of layout templates. (b) Types and features of transfer punches. (c) Methods of attaching templates. (d) Methods of making master templates. (e) Materials used for templates. (f) Principles of heat treatment. (g) Methods of locating the template e.g. dowels, etc. (h) Methods of locating the center of large scribed circles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 6: MISCELLANEOUS LAYOUT TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Transferring a layout to mating parts, such as:</p> <p> an outline hole location, etc.</p>	<p>(a) Methods of establishing the reference point, center line, etc.</p> <p>(b) Types and uses of layout tools.</p> <p>(c) Types and features of adjustable gauges.</p> <p>(d) Types, features and uses of transfer screws.</p> <p>(e) Procedures in the layout of duplicate parts.</p> <p>(f) The "gasket" method of transferring shapes.</p>
<p>3. Laying out a keyway as:</p> <p> external internal</p>	<p>(a) Types, features and functions of keyways.</p> <p>(b) The types and uses of "keyseat rules".</p> <p>(c) Methods of using a center square.</p> <p>(d) Types and features of "layout gauges".</p> <p>(e) Proportions of keys and keyways.</p> <p>(f) Procedures in layout for milling, shaping, chipping, etc.</p>
<p>4. Laying out work for machining, such as:</p> <p> boring mill shaper and slotter planer lathe, etc.</p>	<p>(a) Methods of mounting work.</p> <p>(b) The divisions of layout e.g. preliminary, final.</p> <p>(c) Allowances for machining.</p> <p>(d) Methods of testing "core" locations.</p> <p>(e) The necessity of "partial machining".</p> <p>(f) Blueprint reading and specifications.</p> <p>(g) Types of work laid out for machining e.g. journal cap, cranks, crosshead, engine bed, etc.</p> <p>(h) Methods of using a "tight wire" e.g. piano wire, fish line, etc.</p> <p>(i) The use of graph lines e.g. for positioning work on table.</p> <p>(j) Methods of testing and correcting levels.</p> <p>(k) Safety precautions re slippage of heavy parts.</p> <p>(l) The use of the machine table for laying out work.</p> <p>(m) Techniques of combined layout and setup.</p> <p>(n) Methods of protecting the work e.g. finished parts, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 7: THE WORK BENCH

OPERATIONS	KNOWLEDGE
1. Selecting the bench	<ul style="list-style-type: none"> (a) Factors governing the selection, e.g. the type of work, the number of parts involved, the type of production, as continuous, intermittent, etc. (b) Plant layout. (c) Features and designs of work benches. (d) The work area available.
2. Installing the bench	<ul style="list-style-type: none"> (a) Factors governing the location, e.g. size, quantity and type of work. (b) Methods of installing work benches. (c) Methods of drilling concrete. (d) Types, features and applications of anchoring devices. (e) Types and features of levelling instruments (f) Materials suitable for bench tops. (g) The location of power and light supply. (h) The theory of colour dynamics. (i) The durability of paints and colours. (j) Methods of applying paints. (k) Methods of measuring and testing "candle-power" e.g. meter, etc. (l) The mechanics of "braces" and "Bracing". Physics - Leverage, moments. (m) Types and features of conveyor systems.
3. Maintaining the bench	<ul style="list-style-type: none"> (a) Methods of re-surfacing. (b) The advisability of periodic tightening. (c) Methods of re-levelling. (d) Methods of neutralizing spilled acids. (e) Types, features and applications of cleaning equipment. (f) Methods of maintaining lifting equipment.
4. Installing auxiliary equipment, such as: bench blocks, vises, stakes, tool racks, parts racks, etc.	<ul style="list-style-type: none"> (a) Types of material suitable for bench blocks. (b) Types, features and uses of bench blocks. (c) Methods of mounting bench blocks e.g. loose, pinned, inset, etc. (d) Types, features and applications of bench vises e.g. machinists, pipe, pneumatic, etc. (e) Pressure required in air lines. (f) Types and features of pressure regulators.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 7: THE WORK BENCH

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (g) Methods of mounting vises. (h) The correct height of vises. (i) Types, features and functions of vise equipment e.g. vise jaws, liners, jig attachments, etc. (j) Types, features and applications of "sheet metal stakes". (k) Methods of mounting stakes. (l) Types and features of tool racks. (m) Methods of installing racks. (n) The advisability of "grouping" tools. (o) Methods of handling and transporting work pieces. (p) Features and functions of standard equipment e.g. tote boxes, trays, pack boards, etc.
5. Good housekeeping	<ul style="list-style-type: none"> (a) The habit of replacing tools, accessories, etc. (b) Methods of disposing of oily rags. (c) Types and features of disposal equipment: e.g. chutes, receptacles, etc. (d) Routine cleaning of bench and work area. (e) Periodic replacement of all tools to racks e.g. a fresh start, etc. (f) Methods of scrap disposal. (g) Safety practices e.g. use safety equipment.

BLOCK III: BENCHWORK PRACTICE

UNIT 8: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Holding parts and/or material for bench operations	<ul style="list-style-type: none"> (a) How to hold work securely in a vise e.g. regular shaped, irregular shaped, etc. (b) How to avoid marring finished surfaces. (c) How to hold thin sections to avoid distortion. (d) Types, features and applications of holding devices. (e) The design and use of jigs and fixtures. (f) Methods of holding parts by hand e.g. pin vises, hand clamps, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 8: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (g) Methods of clamping work to the bench top. (h) Types and features of stops and fences. (i) Methods of supporting long bars e.g. slings, stands, etc. (j) Types and features of "stock carriers" e.g. retractable, solid, etc. (k) Methods of lifting and supporting heavy work. (l) Safety precautions e.g. pinched fingers, dropping heavy work, etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 9: HAMMERING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the hammer	<ul style="list-style-type: none"> (a) Factors governing the selection, as: type of work, condition of work, operation to be performed. (b) Types, features and applications of hammers. (c) The identification of common hammers. (d) The condition of the hammer. (e) The "balance" of hammers e.g. "feel", etc.
2. Maintaining the conditions of hammers, such as: machinists, riveting, sledge, soft, mallets	<ul style="list-style-type: none"> (a) The required shape of a hammer face. (b) Methods of grinding and polishing a hammer head. (c) How to "hang" a hammer handle. (d) Materials used for hammer parts e.g. the head, handle, wedge, grips, etc. (e) Types, features and applications of machinists hammers as ball peen, straight peen cross peen. (f) Types and features of riveting hammers. (g) Materials used for soft-faced hammers. (h) Special features of a "loaded" hammer. (i) Safety precautions e.g. avoid striking hardened surfaces, etc. (j) Size-rating of common hammers.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 9: HAMMERING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Using the hammer for: driving, striking, tapping, peening, etc.	(a) The position of the "grip" for (a) heavy work (b) light work. (b) Precautions re "choking" a hammer. (c) The "landing" position of the hammer face. (d) The "wrist motion" for light tapping. (e) Safety practices re use of goggles and avoid hitting vise jaws, grind "mushroom heads", avoid loose heads, etc. (f) Methods of removing grease e.g. solvents, etc. (g) Procedures in peening and riveting. (h) The force required for driving, striking, etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 10: HAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the hand saw, such as: a hacksaw, a slitting saw, etc.	(a) Types, features and applications of hack-saw frames. (b) Types, features and applications of hack-saw blades. (c) Factors governing the selection of the saw frame and blade e.g. type of operation, kind of material being cut, etc. (d) Hacksaw nomenclature. (e) Sizes of hacksaws.
2. Sawing thin material such as: flat stock, thin wall tubing, etc.	(a) The pitch of teeth for sawing thin material. (b) Methods of preventing "biting" e.g. backing pieces, two-blade method, etc. (c) Methods of holding work. (d) Pressure required for sawing. (e) Position of work for sawing e.g. flat-wise if possible, etc. (f) Kinds of material suitable for "sandwich blocks". (g) Types, features and applications of jigs. (h) Tension required on blades.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 10: HAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Sawing heavy sectioned work, such as:</p> <p>bar stock angle iron pipe, etc.</p>	<p>(a) Methods suitable for holding and supporting work.</p> <p>(b) Selection of blade for heavy sections.</p> <p>(c) Methods of starting the cut e.g. filed notch, etc.</p> <p>(d) Speeds used in hand sawing.</p> <p>(e) Types and uses of cutting compounds.</p> <p>(f) Methods of sawing thick parts e.g. reversed frame, etc.</p> <p>(g) Precaution re changing blades in a cut e.g. binding in "kerf", etc.</p> <p>(h) Techniques of following a line e.g. correcting error at each stroke.</p> <p>(i) The necessity of relieving pressure on back stroke.</p>
<p>4. Sawing a slit in thin work, such as:</p> <p>sheets flat stock pipe or tubing, etc.</p>	<p>(a) Methods of supporting work.</p> <p>(b) Types and use of guide strips.</p> <p>(c) Types, features and uses of "frameless" saws e.g. single blade solid, retractable blade, etc.</p> <p>(d) Precautions re breaking blade.</p> <p>(e) The applications of "pull stroke cutting" etc.</p> <p>(f) Types and uses of hand-held power tools.</p> <p>(g) Types of blades for hand power tools.</p>
<p>5. Sawing a slot in small parts, such as:</p> <p>screw heads pins, etc.</p>	<p>(a) Methods of holding work.</p> <p>(b) Methods of protecting finished parts.</p> <p>(c) Types and uses of jigs and fixtures.</p> <p>(d) Methods of cutting a wide kerf e.g. step method, two blade method, special blades.</p>
<p>6. Sawing a contour</p>	<p>(a) Methods of holding work.</p> <p>(b) Types, features and uses of templates.</p> <p>(c) Types of blades for contour sawing e.g. round.</p> <p>(d) The best location of starting holes.</p> <p>(e) Precautions re shifting work on internal cuts e.g. "hanging" on the blade, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 11: CHIPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the chipping chisel	<ul style="list-style-type: none">(a) Types, features and uses of chipping chisels.(b) Sizes of chipping chisels.(c) The design of chipping chisels e.g. cutting end, striking end, etc.(d) Factors governing the selection e.g. type of operations, kind of material in work, etc.(e) Types, features and applications of hand-held power tools, e.g. pneumatic guns, electric, etc.(f) The "action" of a chipping chisel.
2. Maintaining the chisel	<ul style="list-style-type: none">(a) Types of materials used in chisels.(b) Methods of identifying steels.(c) The "Heat Treatment" of "Ferrous" metals.(d) Offhand grinding techniques.(e) Methods of gauging points.(f) Methods of testing re-hardened chisels.(g) Safety practices e.g. remove "mushrooms", soft striking end, etc.(h) Precautions re burning cutting edges while grinding.
3. Chipping a bevel	<ul style="list-style-type: none">(a) Layout procedures.(b) Methods of holding work.(c) Type of chisel required.(d) The type and weight of hammer required.(e) Cold chiseling procedures.(f) Safety practices e.g. goggles, etc.
4. Chipping a flat surface	<ul style="list-style-type: none">(a) Methods of holding work.(b) Preparation of work for surfacing e.g. layout etc.(c) Types and features of chisels used.(d) Methods of roughing out e.g. "cross-grooving", drilling, etc.(e) Methods of drilling flat-bottomed holes to depth.(f) Chipping procedures.(g) The techniques of "power chipping".(h) Sequence of operations in chipping a flat surface.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 11: CHIPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Chipping a keyway, such as:</p> <p> external</p> <p> internal</p>	<p>(a) Methods of holding work.</p> <p>(b) How to layout a keyway for chipping.</p> <p>(c) Allowances for finishing.</p> <p>(d) Types, features and design of chisels e.g. cape chisel, cold chisel, side chisel, etc.</p> <p>(e) Methods of preventing "offside crumbling on castings" e.g. bevel before starting a cut, etc.</p> <p>(f) Keyway standards, etc.</p> <p>(g) Methods of testing and measuring keyways.</p> <p>(h) Methods of "finishing" chipped keyways.</p> <p>(i) Methods of chipping a keyway in the center of a shaft.</p>
<p>6. Chipping an oil groove in a:</p> <p> flat surface (internal and external)</p> <p> curved surface (internal and external)</p>	<p>(a) The design of bearings.</p> <p>(b) Principles of lubrication.</p> <p>(c) Types, features and applications of lubricants.</p> <p>(d) Oil grooving procedures.</p> <p>(e) Types, features and applications of grooving chisels.</p> <p>(f) The size of groove necessary.</p>
<p>7. Cutting irregularly shaped holes, such as:</p> <p> through</p> <p> blind</p>	<p>(a) Layout procedures.</p> <p>(b) The techniques of "outline drilling".</p> <p>(c) Types, features and uses of "drifts".</p> <p>(d) The "action" of a drift.</p> <p>(e) Depth allowance for "blind" holes.</p> <p>(f) The techniques of drifting through holes.</p> <p>(g) Types, features and applications of "sizing drifts".</p> <p>(h) Types and features of cutting lubricants.</p> <p>(i) Types, features and methods of using a simple "push broach".</p>
<p>8. Shearing thin metals with a chisel</p>	<p>(a) Methods of holding work.</p> <p>(b) Types and features of vise jaws.</p> <p>(c) Types, features and uses of shearing chisels e.g. cold, chisel, square edge, etc.</p> <p>(d) Safety precautions re flying particles.</p> <p>(e) The principles of shear cutting.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 11: CHIPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>9. Miscellaneous operations, such as:</p> <p> lining rivet and bolt breaking staking, etc.</p>	<p>(a) Types, features and applications of "lining tools".</p> <p>(b) Types, features and applications of "breaking chisels".</p> <p>(c) Types, features and applications of "staking tools".</p> <p>(d) The principles of "plastic deformation" in materials.</p> <p>(e) The mechanics of breaking chisels. (Science--Triangle of forces.)</p>

BLOCK III: BENCHWORK PRACTICE

UNIT 12: FILING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Selecting the correct file</p>	<p>(a) Factors governing the selection of files e.g. size and shape of work, type of operation, material to be cut, material to be removed, etc.</p> <p>(b) The intended use of files.</p> <p>(c) Material of files.</p> <p>(d) The forms and cuts of file teeth.</p> <p>(e) File terminology.</p> <p>(f) Kinds and classes of files.</p> <p>(g) The grading of files.</p> <p>(h) The shapes of files.</p> <p>(i) The sizes of files.</p> <p>(j) Steps in file manufacture e.g. aids in diagnosis of file failure.</p> <p>(k) Filing procedures.</p> <p>(l) Types, features and applications of file handles.</p> <p>(m) How to identify dull files.</p>
<p>2. Maintaining the file</p>	<p>(a) Methods of mounting file handles.</p> <p>(b) Methods of cleaning files.</p> <p>(c) Types, features and methods of using "file cards".</p> <p>(d) Methods of removing "pins".</p> <p>(e) Types and features of tools used e.g. picks, flat copper, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 12: FILING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none">(f) The effect of oil on filing.(g) Methods of removing oil and grease.(h) Kinds and uses of solvents and cleaners.(i) The use of chalk and whiting in filing.(j) Methods of reconditioning files e.g. sand blast, acid dip, re-cut, etc.(k) Types, features and methods of using sand blasting equipment and acid baths.(l) Safety precautions re sand, acid, etc.(m) The care and storage of files.
3. Filing a flat surface	<ul style="list-style-type: none">(a) Methods of holding work.(b) The correct height of work.(c) The correct position of the operator.(d) How to hold a file e.g. to avoid fatigue.(e) Selecting the correct file, B4, U12, O1.(f) The angle of traverse e.g. right angles, diagonal, lengthwise.(g) The correct speed for filing.(h) Maintaining the file, B4, U12, O2.(i) Methods of removing chips from work.(j) Methods of testing surfaces for "truth".(k) Types, features, applications and care of tools used e.g. straight edge, etc.(l) Precautions re "scoring".(m) Methods of testing for "wind".
4. Filing a straight edge to a flat surface, such as: square, at an angle	<ul style="list-style-type: none">(a) Methods of holding work.(b) Methods of rapid stock removal by filing.(c) How to prevent marring of work by the holding device.(d) Methods of testing an edge for "square" and "straight".(e) Methods of measuring and testing angles e.g. bevel, protractor, gauge.(f) Height of work to prevent "chatter".(g) Correct method of "draw-filing".(h) Factors governing file selection.(i) Safety practices.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 12: FILING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Beveling an outside corner	<ul style="list-style-type: none"> (a) Methods of holding work. (b) Direction of filing action. (c) Precautions re tooth breakage e.g. starting pressure. (d) Methods of laying out a bevel. (e) Techniques of filing to a line. (f) Proportions of bevels. (g) Blueprint reading and specifications.
6. Filing a convex surface	<ul style="list-style-type: none"> (a) Methods of holding work. (b) The selection of files for roughing and finishing. (c) The direction of file action. (d) Methods of testing convex surfaces. (e) How to draw-file a convex surface. (f) Pressure and motion required.
7. Filing a concave surface	<ul style="list-style-type: none"> (a) Methods of holding work. (b) Sections of files suitable for roughing concave surfaces e.g. square, rectangular, etc. (c) Type of files used for finishing concave surfaces e.g. maximum curvature, etc. (d) The file motion used e.g. wrist motion, sweep, etc. (e) The necessity of reversing direction.
8. Filing into a corner, such as: right angled acute angled radius, etc.	<ul style="list-style-type: none"> (a) Methods of holding work. (b) Methods of filing sharp corners. (c) Types and features of files for "cornering". (d) Types and uses of "safe-edged" and "safe-faced" files. (e) Methods of testing inside angles. (f) Care required in "matching" a radius. (g) Features of "safe-round" files. (h) Methods of grinding files. (i) Grinding techniques.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHMARK PRACTICE

UNIT 12: FILING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>9. Internal filing, such as:</p> <p>a slot a groove geometric holes, etc.</p>	<p>(a) Methods of holding work. (b) Techniques of "line-filing". (c) The selection of files required. (d) Types and features of "file-shields". (e) Types, features and applications of guide strips e.g. single or double. (f) Methods of filing to a template. (g) Types and features of "filing plates". (h) Precautions re tooth breakage e.g. hardened guides, etc. (i) Types, features and applications of marking dyes e.g. Prussian Blue, etc. (j) Filing procedures. (k) Methods of filing a long hole.</p>
<p>10. Filing a contoured outline</p>	<p>(a) Methods of holding work. (b) Sequence of operations e.g. curves, straight sections, etc. (c) Types and features of "rotary files" and "burrs". (d) Types and features of hand held power tools e.g. flexible shaft, etc. (e) Types and features of surface finishes. (f) How to finish parts for heat treatment.</p>
<p>11. Freehand filing, such as:</p> <p>deburring, pin and wire filing, etc.</p>	<p>(a) Methods of holding work by hand. (b) Types, features and uses of "pin vises". (c) Care in using die makers files e.g. Swiss pattern, etc. (d) Types and features of "Backing Blocks". (e) Materials for backing blocks e.g. hardwood, etc. (f) Types, features and applications of "pliers", "hand vises", etc. (g) Methods of deburring gear teeth. (h) Testing and inspection methods.</p>
<p>12. Freehand polishing filed work</p>	<p>(a) Methods of holding finished parts. (b) Types, features and applications of abrasive cloths. (c) The grading of abrasives. (d) The order of application e.g. degree of coarseness, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 12: FILING TECHNIQUES

OPERATIONS

KNOWLEDGE

12. Cont'd.

- (e) Types and uses of lubricants.
- (f) Precautions re rounding corners.
- (g) The "direction" of polishing.
- (h) Techniques in removing tool marks.
- (i) Precautions re using polishing sticks e.g. scoring work, etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 13: SCRAPING TECHNIQUES

OPERATIONS

KNOWLEDGE

1. Selecting the scraping equipment, such as:

scrapers,
surface plates,
straight edges,
try squares,
optical flats, etc.

- (a) Factors governing the selection of equipment e.g. size and shape of work, type of operation, accuracy required, etc.
- (b) The scope of scraping.
- (c) Types, features and uses of hand scrapers.
- (d) Methods of using scrapers.
- (e) Types, features and uses of surface plates.
- (f) Materials used for surface plates.
- (g) Sizes of standard "surface plates".
- (h) Types, features and applications of "straight edges".
- (i) Types, features and applications of "try squares".
- (j) Types, features and uses of "optical flats".

2. Maintaining the scraping equipment, such as:

scrapers,
surface plates,
straight edges,
try squares, etc.

- (a) The design and application of scraper points.
- (b) Methods of sharpening scrapers.
- (c) Methods of testing and inspecting scraper points and edges.
- (d) Types, features and applications of testing gauges e.g. solid, adjustable, etc.
- (e) Types, features, applications and care of oil stones.
- (f) Grinding techniques.
- (g) Methods of protecting and storing surface plates, scrapers, etc.
- (h) Methods of testing and checking squares, straight edges, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 13: SCRAPING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (i) Types, features and applications of testing and inspection equipment. (j) Methods of making scrapers from files. (k) Principles of heat treatment.
<p>3. Scraping flat surfaces such as:</p> <p style="padding-left: 40px;">an external flat surface, an internal flat surface, combination internal and external flat surfaces</p>	<ul style="list-style-type: none"> (a) The accuracy and finish required. (b) Preparation of work for scraping. (c) The amount of material to be removed i.e. allowance for scraping. (d) Methods of locating high spots. (e) Types, features and uses of "high spot indicators" e.g. Prussian Blue, Venetian Red, Alcohol, etc. (f) Selecting the scraper e.g. "flat", "hook", "three-square", etc. (g) Techniques of holding the scraper e.g. "angle of approach", "two-hand pull", etc. (h) How to use a surface plate for marking high spots. (i) Scraping procedures for external flat surfaces. (j) Scraping procedures for internal flat surfaces. (k) Scraping procedures for combination surfaces.
<p>4. Scraping an internal curved surface such as:</p> <p style="padding-left: 40px;">stationary, revolving</p>	<ul style="list-style-type: none"> (a) Types, features and characteristics of "bearing surfaces". (b) The requirements of "fit". (c) Methods of marking internal curved surfaces e.g. "bedding", etc. (d) Types, features and applications of "bearing scrapers". (e) Techniques of "two-hand scraping". (f) Methods of testing internal curved surfaces (g) Methods of revolving work e.g. bench power tools, etc. (h) Speeds for "live scraping". (i) Allowances for scraping. (j) Techniques of "power scraping" e.g. avoiding chatter, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 13: SCRAPING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Scraping to correct machining errors such as: threads, centre holes, out of round holes, etc.	(a) Methods of locating the error. (b) Types and features of scrapers for threaded work, centre holes, etc. (c) Types, features and uses of magnifying equipment. (d) Scraping procedures.
6. Scraping to produce an ornamental effect	(a) Reasons for ornamental scraping. (b) "Patterns" for ornamental scraping. (c) Methods of "pattern" scraping. (d) Types and features of power operated "pattern scrapers". (e) Preparation of work surface for ornamental scraping. (f) Precautions re "over scraping" e.g. destroyed accuracy, etc. (g) Types of work requiring ornamentation e.g. machine tools, precision instruments, etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 14: SHEARING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the shearing method	(a) Factors governing the selection of the method e.g. size of work, shape of work, number of pieces to be cut, etc. (b) Methods of shearing materials. (c) Types, features and applications of shearing machines e.g. hand operated, power operated, etc. (d) Power required for shearing. (e) Calculations of force required. (f) Principles of shear cutting. (g) Accuracy obtainable. (h) Types, features and methods of using "snips".

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 14: SHEARING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Selecting the machine, such as:</p> <p>hand operated shears, power operated shears, hand snips, etc.</p>	<p>(a) Types of shearing machines. (b) Space required for the machine. (c) Methods of handling stock. (d) The availability of power. (e) Interpretation of manufacturers' specifications. (f) The capacity required. (g) The kind and amount of possible maintenance. (h) The capacity of hand snips.</p>
<p>3. Installing the machine</p>	<p>(a) Methods of selecting the most efficient location. (b) Types and features of machine foundations e.g. floor mounted, bench mounted. (c) Methods of anchoring machinery. (d) Types, features and applications of anchoring devices e.g. anchor bolts, log screws, etc. (e) Methods of levelling and adjusting the machine. (f) Types and features of levelling equipment. (g) Methods of moving heavy machinery. (h) Methods of installing bench shears e.g. hand operated, power operated. (i) Care and storage of hand shears e.g. "snips". (j) Precautions re allowing for stock movement e.g. stock ports in wall, allow space, etc. (k) Methods of supporting stock.</p>
<p>4. Maintaining the machine or cutting device, such as:</p> <p>power shears, bench shears, plate shears, hand shears (snips), etc.</p>	<p>(a) Types and features of shear blades e.g. plain notched, etc. (b) Methods of removing and replacing shear blades. (c) Methods of sharpening knives. (d) Grinding techniques. (e) Methods of adjusting machine parts, such as blades, hold-down fingers, stock-grips, etc. (f) Principles of lubrication. (g) Types and features of lubricating devices e.g. grease and oil cups, sight feeders, pressure equipment, etc.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 14: SHEARING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (h) Methods of adjusting bench shear blades, etc. (i) Types, features and operation of plate shears e.g. bull shears, hand operated, etc. (j) Methods of sharpening hand shears. (k) Methods of adjusting tension e.g. testing amount, etc. (l) Types, features and uses of hand shears e.g. snips. (m) Safety practices re use of guards etc.
5. Shearing flat stock, such as:	<ul style="list-style-type: none"> (a) Methods of gauging stock length. (b) Methods of shearing to a line. (c) Layout procedures. (d) Standard stock sizes and nomenclature. (e) Amount of post-shear flattening required. (f) Methods of straightening stock. (g) Measuring techniques. (h) Precautions re loose cutters e.g. bending material, etc. (i) Safety practices e.g. hand levers, power cutters, etc. (j) Methods of cutting angles.
hoop iron	
hand iron	
bar stock	
6. Shearing sheet and plate stock, such as:	<ul style="list-style-type: none"> (a) Types, features and operation of plate shears i.e. power and hand operated. (b) The capacity of the machine. (c) Methods of handling and storing sheet metal and plate. (d) Safety practices re leather aprons, gloves, etc. (e) Methods of gauging cut. (f) Procedures in shearing to a line. (g) Standard gauges for sheet metal and plate. (h) Standard stock sizes. (i) Methods of adjusting "pressure plates" and "fingers". (j) Methods of deburring sheared stock.
by power machine	
by hand	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 14: SHEARING TECHNIQUES

OPERATIONS	KNOWLEDGE
7. Shearing structural stock such as steel and/or aluminum alloy: angles channels I-beams, T-sections, round stock, etc.	(a) Types and features of "bull shears". (b) Methods of moving, handling and supporting heavy stock. (c) Types and features of shear blades. (d) Methods of preventing "kick-back" e.g. special vises, stops, etc. (e) Safety practices, e.g. safety shoes, gloves, etc. (f) Methods of supporting I-beams, channels, etc. to prevent distortion when shearing.
8. Shearing small rod and wire	(a) Methods of shearing rod and wire. (b) Methods of handling and storing rod and wire. (c) Types and features of stock reels. (d) Types and features of bench shears for small rod and wire. (e) Types, features and uses of hand cutters e.g. cutting pliers, side cutters, end cutters, etc. (f) Methods of straightening rod and wire. (g) Precautions re dull cutters e.g. deforming sheared end, etc. (h) Methods of shearing stranded cable. (i) Methods of wrapping cable prior to cutting. (j) Types and features of cable cutters.
9. Shearing light gauge plate and sheet materials with hand shears	(a) Types, features and application of hand snips. (b) The vise method of holding snips. (c) Techniques of cutting to a line. (d) Layout techniques. (e) The care and maintenance of hand snips. (f) Methods of flattening light metals. (g) Methods of protecting finished surfaces. (h) Methods of de-burring cut parts.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 14: SHEARING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>10. Shear-cutting geometric shapes, such as:</p> <p>external internal</p>	<p>(a) Principles of geometric construction.</p> <p>(b) Preparation of the work for cutting.</p> <p>(c) Methods of nesting parts e.g. batch cutting, etc.</p> <p>(d) The conservation of materials e.g. minimum scrap, etc.</p> <p>(e) Methods of starting internal cuts e.g. punched hole, drill, etc.</p> <p>(f) Types and features of snips for circle cutting.</p> <p>(g) Precautions re stretching sheet metal e.g. flattening edges, etc.</p>
<p>11. Shearing in the vise such as:</p> <p>straight shear cut circular or contoured small rivets</p>	<p>(a) The requirements of vise jaws for shearing.</p> <p>(b) Techniques of cold chiselling.</p> <p>(c) The scope of vise shearing e.g. size of work, type of cut, etc.</p> <p>(d) Types and features of backing plates e.g. contour shearing, etc.</p> <p>(e) Materials for backing plates.</p> <p>(f) Types and features of shearing jigs e.g. for wire, rivets, etc.</p> <p>(g) Methods of shearing small tubing in the vise.</p> <p>(h) Types and features of shearing mandrels e.g. internal support for tubing, etc.</p> <p>(i) Methods of hand piercing e.g. small louvers etc.</p>
<p>12. Punching holes by bench methods, such as:</p> <p>hand tools portable punches, etc.</p>	<p>(a) Types and features of hand piercing punches and dies.</p> <p>(b) Methods of mounting punch and die in bench vise.</p> <p>(c) Methods of piercing heat treated parts e.g. saw blade, etc.</p> <p>(d) Types of backing blocks e.g. lead, brass, etc.</p> <p>(e) The limitations of hand piercing.</p> <p>(f) The design of piercing punches e.g. shear cutting end, piloted point, etc.</p> <p>(g) Hammering techniques.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 15: FORMING AND BENDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of forming or bending	<ul style="list-style-type: none">(a) Types, features, characteristics and uses of materials.(b) Methods of bending flat stock e.g. band iron, bar stock, etc.(c) Principles of forming and bending e.g. neutral zone, etc.(d) Methods of edgewise bending.(e) Methods of bending round stock.(f) Production methods.(g) Methods of bending tubing and pipe.(h) Principles of "embossing".(i) Principles of hot and cold bending and forming.(j) Principles of heat treatment e.g. plastic heats, annealing, etc.(k) Hot forming techniques.(l) Cold forming techniques.
2. Bending and forming sheet metal, such as: flatwise angular, rolling cylinder, etc.	<ul style="list-style-type: none">(a) Types, features and functions of bending devices e.g. vise bar-folder, dies, etc.(b) Types, features and functions of forming devices e.g. rolls, seamers, etc.(c) Allowances for bends.(d) Methods of testing angles and curves.(e) Calculations for curves and angles.(f) Tools and devices used in flatwise bending and forming.(g) Principles of "dapping" and "dapping dies".(h) Types, features and applications of seams.(i) Techniques of preparation forming.(j) Methods of curling and wiring.
3. Bending and forming flat stock flatwise, such as: hoop iron band iron bar stock	<ul style="list-style-type: none">(a) The limitations of cold bending and forming e.g. maximum size, etc.(b) Methods of bending flat stock.(c) Allowances for spring-back.(d) Types of bends possible in flatwise bending(e) Layout procedures.(f) Principles of "permanent layout".(g) Calculations for length of stock.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 15: FORMING AND BENDING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Bending flat stock edgewise, such as: cold bending hot bending	(a) Types and features of bending machines e.g. jigs, roller types, etc. (b) The capacity of bending equipment. (c) Calculations for bending e.g. mean diameter, etc. (d) Principles of heat bending. (e) Methods of applying heat. (f) Types, features and applications of heating equipment. (g) Principles of quench bending.
5. Bending and off-setting pipe and/or tubing	(a) Types, features and applications of pipe and tube bending equipment. (b) Materials suitable for filling tubing e.g. rosin, lead, sand, etc. (c) Methods of capping filled tubes for bending. (d) Methods of constructing bending guides e.g. jigs, diagrams, etc. (e) Methods of annealing e.g. steel, copper, etc. (f) Precautions re flattening.
6. Bending solid round stock, such as: hot rolled, cold rolled, non-ferrous, etc.	(a) Methods of bending round stock. (b) The action of heat on various metals. (c) The critical point of various metals. (d) Methods of determining temperature e.g. thermocouple, magnet, etc. (e) The limitations of cold and hot bending. (f) Principles of heat treatment.
7. Stretching and forming sheet metal and flat stock	(a) Plastic deformation of materials. (b) The principles of peening and staking. (c) Methods of upsetting. (d) Methods of holding and supporting work materials. (e) Techniques of hammering.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 15: FORMING AND BENDING TECHNIQUES

OPERATIONS	KNOWLEDGE
8. Swaging and/or cold forging by pressure or impact	<ul style="list-style-type: none"> (a) The principles of cold forging. (b) The effect of cold working on metallic materials. (c) Methods of annealing ferrous and non-ferrous materials. (d) The expected accuracy of cold-working equipment. (e) Typical swaging operations e.g. reducing ends of bars, tubes, etc. (f) Types and features of straightening rolls. (g) Principles of cold heading. (h) Force required for cold working. (i) Principles of impart forming. (j) Types, features and applications of equipment used. (k) Types of work cold forged, etc., e.g. bolt heads, etc. (l) Safety Practices re use of safety equipment.
9. Hobbing work: by hand by power	<ul style="list-style-type: none"> (a) The scope of hobbing. (b) Types of work usually hobbled e.g. mould cavities, etc. (c) Kinds of metal suitable for hobbing e.g. soft steel. (d) Frequency of annealing required. (e) Materials suitable for hobs. (f) Pressure required for hobbing. (g) Types and features of bench power presses. (h) Methods of removing surplus metal.

BLOCK III: BENCHWORK PRACTICE

UNIT 16: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of drilling	<ul style="list-style-type: none"> (a) Methods of drilling holes by hand, in bench work. (b) Types, features and applications of hand drills. (c) Types and features of portable power tools e.g. electric, pneumatic, flexible shaft, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 16: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none">(d) The type and accuracy of work to be performed.(e) The size, shape and construction of the work piece.(f) Uses of the "crows-foot" and "old man".(g) Types, features & use of work-holding equipment.
2. Drilling a round parallel hole in benchwork, such as: through, blind	<ul style="list-style-type: none">(a) The capacity of hand drills.(b) Types, features and uses of a hand brace.(c) Layout techniques.(d) Sizes and specifications of standard drills e.g. straight flute, twist drills, etc.(e) Precautions re drill breakage.(f) Diagnosis and correction of drill troubles.(g) Types, features and applications of cutting compounds.(h) Methods of sharpening and gauging drills.(i) Methods of governing depth of hole.(j) Pressure and speed for hand drilling.(k) Precautions re break through.(l) Specifications and use of a pilot hole.(m) Methods of drilling hole perpendicular to surface.(n) Methods of drilling hole at specific angle to surface.(o) Safety Practices re use of power hand drills.
3. Drilling a tapered hole in bench work, such as: through, blind	<ul style="list-style-type: none">(a) Methods of drilling tapered holes.(b) Types and features of stepped drills.(c) Methods of measuring and testing tapered holes.(d) Design and features of flat drills.(e) Methods of sharpening flat drills.(f) Materials suitable for flat drills.(g) Methods of controlling depth.(h) The use and care of portable power tools.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 16: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Spot facing, counterboring and/or countersinking in benchwork	<ul style="list-style-type: none"> (a) Types and features of counterbores. (b) Types and features of spot facers. (c) Design and application of countersinks. (d) Methods of gauging counterbores and countersinks. (e) Methods of preventing chatter e.g. clearance, rake, etc. (f) The design and use of changeable pilots. (g) The necessity of lubrication.
5. Deburring drilled holes in benchwork	<ul style="list-style-type: none"> (a) Methods of removing burrs. (b) Types and features of hand tools. (c) Scraping techniques. (d) Types, features and applications of rotary tools e.g. rotary files, burrs, single cutter, etc. (e) Hand grinding techniques. (f) Safety Practice re use of goggles, face shields etc., when grinding, deburring etc.

BLOCK III: BENCHWORK PRACTICE

UNIT 17: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Reaming a parallel hole, such as: through blind	<ul style="list-style-type: none"> (a) Methods of holding work for reaming e.g. to prevent distortion. (b) Methods of reaming holes in benchwork e.g. portable power tools, by hand, etc. (c) Preparation of holes for reaming. (d) Allowances for reaming. (e) Types, features and applications of hand reamers e.g. solid, adjustable, expansion, special. (f) Methods of holding and turning reamers. (g) Types, features and selection of cutting compounds. (h) Precautions re reversing a reamer e.g. breakage, etc. (i) How to "align ream" in benchwork. (j) Methods of cutting oversize holes with solid reamers. (k) Methods of preventing chatter.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 17: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none">(l) Reamer sharpening techniques.(m) The scope and limitations of reamed holes.(n) Inspecting and testing techniques.(o) Types, features, applications and care of measuring instruments.(p) Precautions re bottoming in blind hole work.(q) Reamer nomenclature.(r) Safety practices re reamer bending when power reaming.(s) Precautions re reamer breakage from bending.(t) Types, features and use of machine reamers.
2. Reaming a tapered hole such as: through blind stepped	<ul style="list-style-type: none">(a) Features and applications of taper reamers e.g. power operated, hand operated.(b) Types and uses of standard tapers e.g. taper pin, morse, etc.(c) Preparation of holes for taper reaming.(d) Types and applications of roughing reamers e.g. stepped, notched, etc.(e) Power required for taper reaming.(f) Methods of gauging tapered holes.(g) Methods of applying end pressure in stepped-hole work e.g. draw in, push type, etc.(h) Methods of removing broken reamers e.g. in blind hole work.(i) Precautions re forcing a cut.(j) Reaming procedures.(k) Chip control and disposal.(l) Diagnosis and correction of reaming troubles.
3. Reaming miscellaneous work, such as: pipe reaming, deburring, die making, etc.	<ul style="list-style-type: none">(a) Specifications and applications of pipe reamers e.g. power operated, hand operated.(b) Types, features and applications of burring reamers.(c) Types and applications of a "repair reamer" e.g. enlarge holes in thin metal, etc.(d) Methods of driving reamers in benchwork e.g. tap wrench, brace, portable power, etc.(e) The uses and features of bridge reamers e.g. in assembly work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 17: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (f) Specifications and uses of a toolmaker's reamer. (g) Layout procedures. (h) Drilling practices. (i) Precautions re forcing reamers.

BLOCK III: BENCHWORK PRACTICE

UNIT 18: TAPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Tapping a through parallel hole, by hand by power	<ul style="list-style-type: none"> (a) Methods of holding benchwork for tapping. (b) Preparation of work for tapping e.g. countersink, counter-bore, etc. (c) The use of specifications e.g. handbooks, tables, etc. (d) Types, features and applications of standard screw threads. (e) Screw thread calculations e.g. pitch diameter, tap drill size, etc. (f) Drilling techniques. (g) The selection of taps e.g. hand taps, power taps, etc. (h) Methods of holding and driving hand taps. (i) Types, features and applications of tap wrenches. (j) Methods of holding and driving taps with power tools used in benchwork. (k) Types, features and applications of power tools used in benchwork. (l) Types, features and applications of hand & machine taps. (m) Production methods in benchwork. (n) Types, features and uses of cutting compounds. (o) How to make a tap cut oversize. (p) How to avoid cutting oversize. (q) Tool grinding techniques. (r) The care and storage of taps. (s) Precautions re tap breakage.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 18: TAPPING TECHNIQUES

1. Cont'd.
 - (t) Precautions re correcting a false start e.g. side pressure.
 - (u) Types and features of "alignment jigs".
 - (v) How to remove broken taps.
 - (w) Methods of gauging & testing tapped holes.

2. Tapping a blind parallel hole,
 - by hand
 - by power
 - (a) Preparation of work for blind hole tapping.
 - (b) Selection of hand taps for blind hole work.
 - (c) Selection of bottoming taps for tapping blind holes by power.
 - (d) Methods of controlling depth of tapped hole.
 - (e) Precautions re bottoming.
 - (f) Precautions re chip control and disposal e.g. packing in flutes.
 - (g) Types, features and uses of tapping plugs e.g. plastic type, etc.
 - (h) Thread calculations i.e. thread relief, etc.
 - (i) How to remove broken taps from blind holes.
 - (j) How to repair a stripped thread.
 - (k) Types and features of thread gauges.

3. Tapping a tapered thread in benchwork, by hand
 - (a) Methods of rigidly mounting and holding work.
 - (b) The preparation of work for pipe tapping.
 - (c) Specifications and applications of standard pipe threads e.g. N.P.T.
 - (d) Taper reaming techniques.
 - (e) Methods of testing and checking female threads.
 - (f) The use of tap drill tables and specification charts, handbook, etc.
 - (g) Precautions when re-threading e.g. crossed threads, etc.
 - (h) Power required for tapping a tapered thread.
 - (i) Precautions re tap breakage.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 19: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Cutting a parallel thread on round stock, such as:</p> <p>solid rod pipe tubing, etc. with a parallel thread</p>	<p>(a) Methods of holding work for threading. (b) Types, features and applications of standard hand dies. (c) Preparation of stock for threading. (d) Standard markings for taps and dies. (e) Screw thread tolerances. (f) Methods of setting adjustable hand dies. (g) Tool grinding techniques. (h) Methods of holding and driving dies e.g. stocks, etc. (i) Methods of chip control. (j) The selection and use of cutting compounds. (k) Calculations for screw threads e.g. wall thickness, neck diameter, etc. (l) Types, features and applications of thread gauges. (m) Threading practices. (n) Types, features and uses of power threading machines. (o) Precautions re starting dies straight.</p>
<p>2. Cutting a parallel thread on round stock to a shoulder</p>	<p>(a) Types and designs of shaft shoulders. (b) Methods of threading to a shoulder. (c) Identification of mating chasers e.g. matched serial numbers, etc. (d) Methods of adjusting dies to size. (e) Precautions when using reversed position e.g. chipped last tooth, etc.</p>
<p>3. Cutting a tapered thread in benchwork</p>	<p>(a) Methods of holding pipe and round stock for cutting pipe threads. (b) Specifications of standard pipe threads i.e. tapered, parallel. (c) Methods of threading close nipples. (d) Applications and limitations of tapered threads. (e) The requirements of pressure joints. (f) Preparation of work for threading. (g) Types and uses of leaders for precision cut threads. (h) Methods of gauging, testing and measuring tapered threads. (i) Types, features and uses of measuring instruments.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 19: THREADING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (j) Types and uses of thread gauges e.g. solid, adjustable. (k) Precautions re backing off e.g. avoid tearing threads. (l) Techniques of starting the die for re-work. (m) Methods of adjusting dies.

BLOCK III: BENCHWORK PRACTICE

UNIT 20: RIVETING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of riveting, such as: hot riveting cold riveting	<ul style="list-style-type: none"> (a) Factors governing the choice of method e.g. size of work, requirements of joint, etc. (b) Scope and limitations of hot and/or cold riveting. (c) Types and applications of riveted joints. (d) Relative strength of joints. (e) The types of, and reasons for joint failures. (f) Calculations for riveted joint efficiency. (g) Interpretation of Boiler Code. (h) The kinds and application of engineering handbooks and data. (i) Plastic deformation of materials. (j) Methods of testing materials e.g. identification, etc. (k) Methods of testing a riveted joint. (l) Methods of bucking up while riveting. (m) Preparations and operations necessary prior to riveting e.g. condition of mating parts, straightening, etc. (n) Physical properties of materials e.g. strength, coefficient of expansion, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 21: GRINDING OFFHAND

OPERATIONS	KNOWLEDGE
1. Grinding work held by hand	<ul style="list-style-type: none"> (a) Types of work performed by offhand grinding. (b) Types and features of bench grinders. (c) Types and features of pedestal grinders. (d) Types and features of portable grinding equipment. (e) Types and features of wheels used on bench and pedestal grinders. (f) Types of bonds used on wheels for general purpose grinding. (g) Safe operating speeds for bench and pedestal grinders. (h) Methods used to provide adequate wheel guards. (i) Types, features and functions of work rests. (j) Wheel efficiency obtainable when grinding by hand. (k) Methods of installing and servicing bench and pedestal grinders. (l) Methods of mounting wheels for bench and pedestal grinders. (m) Types and features of wheel flanges. (n) Methods of controlling dust. (o) Methods of testing wheels before mounting e.g. ring test. (p) Care and maintenance of bench and pedestal grinders. (q) Methods of grinding single point or single edged tools. (r) Methods of dressing grinding wheels. (s) Types and features of wheel dressers for offhand wheel dressing (e.g.: star, etc.) (t) Grinding procedures. (u) Surface finish obtainable (v) Methods of grinding chisels or chipping tools. (w) Precautions re overheating tools. (x) Location of grinder in relation to other equipment in the shop. (y) Safety practices--wear goggles or face shields. (z) Methods of using the bench grinder for spark testing materials. (aa) Safety practices e.g. proper position of work rest to avoid jamming and injuring fingers.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 21: GRINDING OFFHAND

OPERATIONS	KNOWLEDGE
2. Grinding work off-hand using a portable grinder	<ul style="list-style-type: none"> (a) Types of work requiring portable grinders. (b) Types and features of portable grinding equipment. (c) Methods of supporting work when using portable grinders. (d) Methods used for guarding wheels on portable grinders. (e) Wheels recommended for portable grinders. (f) Types of bonds suitable for portable grinding wheels. (g) Types and features of organic bond wheels for high speeds. (h) Safety practices - use face shields and goggles. (i) Grinding procedures. (j) Types and features of flexible shaft grinders. (k) Power required for portable grinding equipment. (l) Grinding wheel safe speeds. (m) Methods used for checking wheel speeds. (n) Safety practices - use wheel recommended for speed of machine. (o) Using portable grinders on welded work. (p) Methods of dressing wheels on portable grinders. (q) Types and features of mounted points. (r) Methods of holding and driving mounted points. (s) Types and features of light high speed grinders used for die work.

BLOCK III: BENCHWORK PRACTICE

UNIT 22: POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Polishing a surface by hand	<ul style="list-style-type: none"> (a) Types of work requiring polishing by hand. (b) Methods of holding polishing devices. (c) Speeds for polishing. (d) Types and features of work holding devices. (e) Methods of mounting polishing and buffing wheels.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 22: POLISHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (f) Methods of applying abrasive to wheels. (g) Pressures required for polishing. (h) Selection of abrasives for various finishes. (i) Wheel speeds for polishing. (j) Methods of protecting finished surfaces. (k) Methods of handling polished parts. (l) Methods of polishing contoured work. (m) Speeds for polishing belts. (n) Methods of mounting polishing belts. (o) Recognition of glazed or loaded wheels. (p) Types and features of portable equipment for driving small buffs. (q) Methods of tearing and cutting abrasive cloths. (r) Surface finish obtainable by polishing. (s) Methods of measuring surface finish. (t) Operating precautions re heat e.g. handling (u) Operating precautions re wheel and work rotation. (v) Operating precautions re rounded corners. (w) Safety practices re flying particles e.g. goggles, face shields. (x) Safety practices re grabbing principle of trailing work to polishing device.

BLOCK III: BENCHWORK PRACTICE

UNIT 23: LAPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Lapping a flat surface.	<ul style="list-style-type: none"> (a) Theory of lapping. (b) Types, features and functions of laps e.g. male, female, flat, etc.
work held by hand	<ul style="list-style-type: none"> (c) Types of work requiring lapping. (d) Types and features of abrasives used in lapping compounds. (e) Preparation of work for lapping. (f) Speeds for lapping. (g) Types of prepared lapping compounds. (h) Methods of charging laps. (i) Allowances for lapping. (j) Types and features of lapping lubricants. (k) Methods of applying lubricants.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 23: LAPPING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (l) Methods of cleaning laps and lapped work. (m) Materials suitable for laps. (n) Pressure required in lapping. (o) Methods of lapping a flat face. (p) Recognition of worn or damaged laps. (q) Lapping procedures. (r) Surface finish obtainable by lapping. (s) Types and features of solvents and cleaning solutions. (t) Methods of lapping to a shoulder. (u) Accuracy obtainable by lapping. (v) Diagnosis and correction of lapping troubles. (w) Care and storage of laps. (x) Methods of dressing laps. (y) Methods of maintaining accuracy when lapping. (z) Methods of obtaining a broken pattern e.g. reciprocating. (aa) Speeds and feeds for diamond laps. (ab) Principles involved in using diamond laps. (ac) Methods of handling lapped parts e.g. care and storage.

BLOCK III: BENCHWORK PRACTICE

UNIT 24: BELT FASTENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Fastening a flat belt	<ul style="list-style-type: none"> (a) Types, features and functions of flat belts. (b) Methods of fastening belts using leather lace. (c) Methods of laying out belt for punching when using leather lace. (d) Materials used in the manufacture of belts. (e) Types and features of belt clamps e.g. to support belt when lacing. (f) Lacing procedures. (g) Methods of using copper or brass wire for lacing. (h) Types of commercial belt fasteners e.g. clipper, alligator, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 24: BELT FASTENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (i) Types and features of belt punches. (j) Methods of measuring belts. (k) Types of belt cements. (l) Methods of scarfing belts for joining. (m) Methods of cementing flat belts.
2. Fastening a round or V-belt	<ul style="list-style-type: none"> (a) Types, features and functions of round leather belts. (b) Types, features and functions of non-continuous V-belts (link type). (c) Clips used in joining round belts. (d) Methods of allowing for stretch. (e) Methods of slipping links in V-belts.

BLOCK III: BENCHWORK PRACTICE

UNIT 25: ARBOR PRESS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Pressing out a mandrel.	<ul style="list-style-type: none"> (a) Types, features and functions of arbor presses. (b) Types of hydraulic presses. (c) Types of screw presses. (d) Types of rack and pinion presses. (e) Methods of supporting work when pressing. (f) Pressing procedures. (g) Advantages of using a press. (h) Preparation of work for pressing. (i) Methods of preventing work seizure when pressing. (j) Precautions re direction of press against the taper. (k) Methods of lubricating work when pressing. (l) Types and features of press lubricants. (m) Precaution re dropping of mandrel after pressing out. (n) Pressures obtainable when pressing. (o) Safety Practices re crushed fingers.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 25: ARBOR PRESS TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Bending work in the arbor press	<ul style="list-style-type: none"> (a) Types of work suitable for bending in the press. (b) Preparation of work for bending. (c) Allowances for bends. (d) Methods of supporting work for bending. (e) Methods of avoiding marking of work. (f) Types of bending dies suitable for use in the arbor press.

BLOCK III: BENCHWORK

UNIT 26: SOFT SOLDERING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the solder and soldering equipment	<ul style="list-style-type: none"> (a) The type of joint necessary. (b) Features and applications of soldered joints. (c) Preparation of the work for soldering. (d) Methods of soldering. (e) Methods of applying heat to work. (f) Features and applications of soldering equipment. (g) Classifications and uses of solder. (h) Methods of preparing solder. (i) Types, features and applications of crucibles e.g. clay, etc. (j) Procedures in preparing solder e.g. melt tin first, etc. (k) Proportions of constituents of solders. (l) Types, features and applications of fluxes. (m) Methods of preparing killed spirits. Science-Chemistry. (n) Precautions re chemical reaction i.e. exothermic, etc. (o) Methods of testing for neutrality e.g. litmus paper, etc. (p) Time required to prepare zinc chloride (killed spirits).

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 26: SOFT SOLDERING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Soft soldering by using a soldering iron, such as:</p> <p>solid copper electric elements gun type, etc.</p>	<p>(a) The applications and limitation of copper-bit work.</p> <p>(b) Types and features of soldering bits e.g. straight, hatchet bit, swivel-iron, etc.</p> <p>(c) Methods of tinning the iron.</p> <p>(d) Methods of testing heat.</p> <p>(e) Procedures in filing the point.</p> <p>(f) Methods of chemically cleaning the iron e.g. Sal-ammoniac.</p> <p>(g) Precautions re overheating a tinned iron e.g. burning, etc.</p> <p>(h) Soldering procedures.</p> <p>(i) Factors governing the selection of the iron e.g. size and shape of work, heat required, etc.</p> <p>(j) Types, features and applications of heating equipment.</p> <p>(k) Kinds of metal that may be soft soldered.</p> <p>(l) Methods of applying flux e.g. swab, brush, etc.</p> <p>(m) Precautions re clothes e.g. acid, etc.</p> <p>(n) Personal hygiene e.g. keep hands off face, etc.</p> <p>(o) Types, features, applications and limitations of electric soldering irons.</p>
<p>3. Soft soldering by using an open flame, such as:</p> <p>commercial gas and air acetylene and air etc.</p>	<p>(a) Types and applications of sweated joints.</p> <p>(b) Preparation of parts for sweating.</p> <p>(c) Methods of cleaning surfaces.</p> <p>(d) The theory of capillary action Science-Physics.</p> <p>(e) Methods of holding work.</p> <p>(f) Jig and fixture design.</p> <p>(g) Sweating procedures.</p> <p>(h) Fuel-air ratios Science-Chemistry.</p> <p>(i) Types, features and uses of commercial gas equipment.</p> <p>(j) The use and care of torches.</p> <p>(k) Methods of setting and adjusting a torch flame.</p> <p>(l) Recognition of flame zones e.g. combustion, neutral, etc.</p> <p>(m) Methods of regulating heat e.g. angle of application.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 26: SOFT SOLDERING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (n) Precautions re overheating work e.g. decomposition of solder, etc. (o) Precautions re gas equipment e.g. fumes, etc. (p) The use and operation of gas detecting equipment. (q) Methods of testing for leaks. (r) Types, features and uses of the lamp and blow pipe e.g. small work. (s) Methods of using alcohol lamps. (t) Types of joints suitable for flame soldering.

BLOCK III: BENCHWORK PRACTICE

UNIT 27: BABBITTING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Babbitting a bearing	<ul style="list-style-type: none"> (a) Types, features and functions of babbitted bearings. (b) Types of commercial babbitts. (c) Preparation of work for babbitting. (d) Types of babbitt locks. (e) Methods of tinning bearings. (f) Tinning procedures. (g) Methods of preheating. (h) Correct heats for melting babbitt. (i) Methods of testing babbitt for correct pouring heat e.g. pine stick. (j) Types and features of babbitting mandrels. (k) Methods of controlling babbitt flaw. (l) Precautions re overheating babbitt. (m) Melting points of common babbitts. (n) Materials suitable for babbitt mud. (o) Types of bearings requiring babbitt. (p) Methods of finishing babbitt bearings. (q) Methods used to provide for oil channels. (r) Methods of pouring split bearings. (s) Methods of preventing babbitt from sticking to mandrel. (t) Methods of pouring thrust bearings. (u) Precautions against moisture in bearing. (v) Safety practices - use of face shields and goggles when pouring.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 28: FITTING AND ASSEMBLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting, installing and maintaining the work area	<ul style="list-style-type: none"> (a) The requirements of the assembly shop e.g. floor or pit erecting. (b) Techniques of fitting and adjusting. (c) Designs of permanent foundations. (d) Materials of construction e.g. concrete, stone, steel, timber, etc. (e) Designs and applications of anchor bolts, etc. (f) Methods of setting anchor bolts. (g) Precautions re explosions e.g. lead-moisture, etc. (h) Types and features of templates for setting anchor bolts. (i) Kinds of common erecting floors e.g. tar concrete, cast iron plate, etc. (j) Construction and use of floor pits. (k) Lighting requirements. (l) Features of underground wiring and fixtures. (m) Types, features and uses of levelling equipment. (n) Types and features of dynamometers. (o) Types, features and uses of air compressors and equipment. (p) Types and features of ventilation equipment. (q) Heating requirements. (r) Facilities necessary for care and storage of erection tools and appliances.
2. Selecting erection tools and/or appliances	<ul style="list-style-type: none"> (a) Factors governing the selection of equipment e.g. size of work, type of machine, accuracy necessary, weight, etc. (b) Divisions of erecting e.g. shop, field. (c) Types, features and applications of pinch bars and rollers. (d) Types, features and applications of blocks and trestles. (e) Types, features and applications of jacks e.g. top levelling, geared, hydraulic, etc. (f) Methods of handling and moving heavy parts. (g) Types and applications of hoists and trucks. (h) Principles of block and tackle. Science-Mechanics. (i) Types, features and applications of a block and tackle.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE

UNIT 28: FITTING AND ASSEMBLING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (j) Types and features of chain blocks i.e. differential, geared, etc. (k) Types, features and methods of using hoists e.g. pneumatic, electric. (l) Types and applications of cranes e.g. portable, hand operated, trolley, etc. (m) Types, features and uses of tractors, lift trucks, etc. (n) Methods of constructing derricks, gin pole, etc. (o) Materials used for ropes and slings. (p) Methods of lashing rigging. (q) Techniques of rope splicing e.g. knots, bends, hitches, etc. (r) Tools used for splicing rope and cable. (s) Safety precautions for ropes and chains. (t) Calculating safe working loads. (u) Safety precautions for chains and ropes. (v) Types, features and applications of assembly tools such as wrenches, screw drivers, pliers. (w) Types, features and applications of hand power tools e.g. impact wrenches, power drills, power grinders, etc. (x) Safety practices re crushed toes, fingers, etc.
3. Fitting of component parts, such as:	<ul style="list-style-type: none"> (a) The requirements of keyed joints. (b) Chipping techniques (B4, U11, O5). (c) Filing techniques (B4, U12, O3). (d) Scraping techniques (B4, U13, O1, 2, 3, 4). (e) Drilling techniques (B4, U16). (f) Reaming techniques (B4, U17). (g) Tapping techniques (B4, U18). (h) Threading techniques (B4, U19). (i) Riveting techniques (B4, U20). (j) Offhand grinding techniques (B4, U21). (k) Honing techniques (B4, U22). (l) Lapping techniques (B4, U24). (m) Cleaning techniques (B4, U25). (n) Arbor press techniques (B4, U27). (o) Designs and functions of cotters. (p) Allowances for fitting. (q) Classifications and applications of fits. (r) Gear design and applications.
keys cotters shafts gears flywheels linkage bearings, etc.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHMARK PRACTICE

UNIT 28: FITTING AND ASSEMBLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (s) Backlash requirements. (t) Methods of assembling fitted parts e.g. force fit, shrink fit, etc. (u) Types, features and operation of hydraulic presses e.g. stationary, portable. (v) The influence of temperature on fits. (w) Types and features of sectional fits i.e. for shrinking. (x) Methods of machining flywheels in place e.g. grinding, etc. (y) Methods of rotating parts in place. (z) Designs and applications of toggles and linkages. (aa) Calculations of mechanical advantage. (ab) Principles of mechanics. (ac) Power loss due to friction. (ad) Principles of lubrication. (ae) Bearing design and application. (af) Methods of checking bearing clearance. (ag) Safety practices re use of various tools and machines.

BLOCK III: BENCHMARK PRACTICE

UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
1. Measuring, testing and inspecting with a steel rule	<ul style="list-style-type: none"> (a) Accuracy obtainable. (b) Types of steel rules. (c) Reading of calibrations. (d) Types of calibrations. (e) Care and storage of steel rules. (f) Recognition of worn or damaged steel rules. (g) Selection of the correct rule for the job e.g. width of rule, length of rule, etc. (h) Accessories for steel rules e.g. holders, clamps, hook, etc. (i) Aids for steel rule measurement e.g. surface plate, angle plate, etc. (j) Causes for erroneous readings e.g. parallax, dirt, poor lighting, etc. (k) Calculation from fractions to decimal fractions.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (l) Techniques for measuring diameters and lengths. (m) History of measurement. (n) Various manufacturers of the steel rule and quality of their product. (o) Reading techniques e.g. one and eleven sixteenths plus one sixty fourth - $1 \frac{11+1}{16 \ 64}$. (p) Blueprint and sketch reading. (q) Thickness of graduations. (r) Types and features of circumference rules and other scales.
2. Measuring, testing and inspecting with a steel tape	<ul style="list-style-type: none"> (a) Types and features of various steel tapes. (b) Care and storage of tapes. (c) Precaution re "kinking". (d) Precaution re "bow" in tape on long measurements. (e) Calculation for internal measurements (Maths-formulae). (f) Accuracy obtainable. (g) Various manufacturers of the steel tape and the quality of their work. (h) Types of work a steel tape is used on e.g. circumference of large pulleys, long shafts, etc.
3. Measuring, testing and inspecting angles with a protractor	<ul style="list-style-type: none"> (a) Types and features of protractors. (b) Adjustment of protractor to various angles e.g. dial reading. (c) Accuracy obtainable. (d) Accuracy required. (e) Methods of testing a protractor for accuracy. (f) Calculations for angles. (g) Blueprint reading. (h) Precaution re cleanliness with "combination" sets. (i) Techniques for measuring angles with a protractor. (j) Common errors when setting protractors.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
4. Measuring, testing and inspecting with a try square	<ul style="list-style-type: none">(a) Types and features of combination squares.(b) Types and features of precision squares.(c) Care and storage of squares.(d) Methods of testing squares for accuracy.(e) Fundamentals of using a square e.g. methods of holding square, holding to light, etc.(f) Accessories used with a square e.g. surface plate, feeler gauges, etc.(g) Precaution re cleanliness of work and square.(h) Selection of the correct square for the job(i) Classification of different size squares.
5. Measuring, testing and inspecting from a surface plate	<ul style="list-style-type: none">(a) Methods of checking and inspecting surface plates for truth.(b) Care and storage of surface plates.(c) Types and features of surface plates.(d) Methods of removing nicks and burrs.(e) Methods of cleaning the surface.(f) Diagnosis and correction of surface plate troubles e.g. uneven footing, etc.(g) Optional surface plates e.g. optical flats, plate glass, etc.(h) Accessories and tools used with surface plates e.g. angle plates, surface gauge, etc.(i) Recognition and repair of worn surface plates.(j) Advantages of the iron surface plate.(k) Principles of wringing work on a plate.(l) The use of mechanics blue for flatness testing.(m) Precautions re damaging surface plates from dents, acid, moisture, etc.
6. Measuring, testing and inspecting from an angle plate	<ul style="list-style-type: none">(a) Types and features of angle plates.(b) Methods of testing angle plates for truth.(c) Work holding techniques for angle plates.(d) Care and storage of angle plates.(e) Methods of removing nicks and burrs.(f) Precaution re dropping or bumping.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
7. Measuring, testing and inspecting with a surface gauge	<ul style="list-style-type: none"> (a) Types and features of surface gauges. (b) Techniques used in setting a surface gauge. (c) Accessories used with a surface gauge e.g. dial indicator, scriber, etc. (d) Accuracy obtainable. (e) Blueprint reading. (f) Diagnosis and correction of surface gauge work. (g) Care and storage of surface gauges. (h) Safety practices re hazard-sharp scriber point.
8. Measuring, testing and inspecting with outside calipers, such as: firm joint spring toolmakers lock joint transfer, etc.	<ul style="list-style-type: none"> (a) Types and features of outside calipers. (b) Selection of the caliper for the job. (c) Methods used in setting or adjusting calipers. (d) Working tolerance for calipers. (e) Various manufacturers of calipers and the quality of their product. (f) Precaution re spring calipers not "seating" on nut. (g) The "feel" of outside calipers on size. (h) Methods of setting to a steel rule, inside micrometers, etc. (i) Methods of tightening or loosening firm joint calipers. (j) Precaution re parallax when reading size. (k) Types of measurement obtained with calipers e.g. diameter, thickness, width, taper, etc.
9. Measuring, testing and inspecting with inside calipers, such as: firm joint spring toolmakers lock joint transfer, etc.	<ul style="list-style-type: none"> (a) Types and features of inside calipers. (b) Methods of setting or adjusting calipers. (c) Methods used for adjusting to a plain steel rule. (d) Precaution re rule being 90° to surface plate. (e) The "feel" of inside calipers on size. (f) Precaution re having a clean bore. (g) Accuracy obtainable. (h) Methods used for obtaining true diameter. (i) Precaution re spring caliper legs being squeezed.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHMARK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
9. Cont'd.	(j) Selection of the correct caliper for the job. (k) Care and storage of calipers.
10. Measuring, testing and inspecting with vernier calipers	(a) Types and features of vernier calipers. (b) Manufacturers of vernier calipers and the quality of their product. (c) Principles of vernier reading. (d) Methods of checking and inspecting vernier calipers for "truth". (e) Various jaw conditions which result in inaccurate readings. (f) Precaution re twisting when on work. (g) Care and storage of vernier calipers. (h) The "feel" of vernier calipers on size. (i) Techniques for "centralizing" on inside diameter measurement. (j) Accuracy obtainable with vernier calipers. (k) Use of magnifying glass as a reading aid.
11. Measuring, testing and inspecting with a vernier depth gauge	(a) Types and features of vernier depth gauges. (b) Procedures in adjusting the vernier. (c) Common causes for erroneous readings. (d) Methods of checking and testing depth gauges for true reading. (e) Precaution re true reference surface. (f) Accuracy obtainable with a vernier depth gauge.
12. Measuring, testing and inspecting with a vernier bevel protractor	(a) Types and features of vernier bevel protractors. (b) Work requiring a vernier bevel protractor reading. (c) Principles of a vernier bevel protractor. (d) Care and storage of a vernier bevel protractor. (e) Accuracy obtainable with a vernier bevel protractor. (f) Procedures in checking various angles with a vernier bevel protractor. (g) Precaution re reading the complementary angle. (h) Methods of adjusting the vernier plate.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
13. Measuring, testing and inspecting with a vernier height gauge	<ul style="list-style-type: none"> (a) Types and features of vernier height gauges. (b) Types and features of accessories for a height gauge. (c) Care and storage of the vernier height gauge and accessories. (d) Scope of work done with a vernier height gauge and accessories. (e) Accuracy obtainable. (f) Procedures in setting up and using the vernier height gauge and accessories. (g) Methods of checking and testing for accuracy. (h) Necessity of a good surface plate. (i) Method of sharpening a scribe point. (j) Precaution re tilting. (k) Effect of temperature on readings. (l) Methods of handling e.g. by base.
14. Measuring, testing and inspecting with outside micrometer calipers	<ul style="list-style-type: none"> (a) Types and features of micrometers. (b) Principles of reading a micrometer. (c) Names of the micrometer parts. (d) Methods of checking the anvil face for truth. (e) Causes for erroneous readings e.g. worn thread, etc. (f) Vernier reading on micrometers. (g) Precaution re cleaning extension standards and frame seat before assembling. (h) Care and storage of micrometers. (i) Methods of cleaning the measuring surfaces. (j) Methods of adjusting various micrometers for true treading. (k) Calculation of fractions to decimal fractions. (l) Reliable manufacturers of micrometers. (m) Methods of holding micrometers. (n) Techniques for measuring. (o) Precaution re tipping or canting when measuring. (p) Precaution re leaving spindle and anvil touching when stored. (q) Precautions re improper handling to avoid damage of micrometers.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
15. Measuring, testing and inspecting with inside micrometers	<ul style="list-style-type: none">(a) Types and features of inside micrometers.(b) Techniques used in making internal measurements.(c) Care and storage of inside micrometers.(d) Effect of heat on larger micrometers.(e) Causes of erroneous readings e.g. spindle turning during sizing, etc.(f) Methods of checking micrometers for accuracy.(g) Accuracy obtainable.(h) Methods of cleaning and assembling "mikes".(i) Recognition of worn caliper tips.
16. Measuring, testing and inspecting with small hole and telescopic gauges	<ul style="list-style-type: none">(a) Types and features of small hole and telescopic gauges.(b) Accuracy obtainable.(c) Techniques for transferring size from work to micrometers.(d) Advantages of telescopic and small hole gauges.(e) Method of sizing gauges.(f) Reliable manufacturers of gauges.(g) Necessity of "fine feel" when setting gauges.
17. Measuring, testing and inspecting with gauge blocks	<ul style="list-style-type: none">(a) Types and features of gauge blocks.(b) Care and storage of gauge blocks.(c) Calculations for "stacks".(d) Techniques for "wringing" stacks.(e) Quality of various sets e.g. inspection, laboratory and shop set.(f) Methods of checking blocks for accuracy.(g) Cost of gauge blocks.(h) Accessories used with gauge blocks.(i) Methods of using accessories.(j) Type of work requiring gauge blocks.(k) The history of measurement and gauge blocks.(l) Techniques for handling blocks e.g. by sides, etc.(m) Principle of adhesion with gauge blocks.(n) Precaution re breathing on or moistening to obtain adhesion.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
17. Cont'd.	(o) The necessity for cleanliness. (p) Advantages of wear blocks. (q) Effect of temperature on blocks. (r) Precautions re improper handling to avoid damage to gauge blocks.
18. Measuring, testing and inspecting with feeler gauges	(a) Types and features of feeler gauges. (b) Calculation of multiple leaves. (c) Care and storage of feeler gauges. (d) Accuracy obtainable with feeler gauges. (e) Recognition of damaged leaves. (f) Methods of checking feelers for wear. (g) Types of work feeler gauges are used on.
19. Measuring, testing and inspecting with radius and template gauges	(a) Types and features of radius gauges. (b) Reasons for fillets and rounded corners. (c) Accuracy obtainable. (d) Location of light. (e) Recognition and correction of faulty gauges. (f) The use of paper as a "feeler" in template work. (g) Care and storage of radius and template gauges.
20. Measuring, testing and inspecting with gauges, such as: snap plug ring thread pin etc.	(a) Types and features of fixed gauges. (b) Methods of adjusting fixed gauges. (c) Methods of using a fixed gauge. (d) Nomenclature and terminology. (e) Methods of checking the gauge for accuracy. (f) American gauge design standards for plug and ring gauges. (g) Limitations of gauges. (h) Selection of the correct gauge for the job e.g. snap gauge, ring gauge, etc. (i) Precaution re keeping oil film on ring and plug gauges. (j) Methods of removing "seized" gauges. (k) Necessity of checking the go - no go sizes with the blueprint. (l) Recognition of wear.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
20. Cont'd.	<ul style="list-style-type: none">(m) Types of special gauges e.g. taper, spline, keyways, thread, etc.(n) Care and storage of gauges.(o) Precautions re gauge damage from incorrect handling.
21. Measuring, testing and inspecting with a dial indicator	<ul style="list-style-type: none">(a) Types and features of dial indicators.(b) Mechanical principles of the dial indicator.(c) Construction of the dial indicator.(d) Types of dial faces e.g. balanced, continuous, etc.(e) Nomenclature of dial indicator components.(f) Selection of the indicator.(g) Reasons for indicators "over-travel".(h) Factors limiting the indicator's "range" or capacity.(i) Accessories and equipment used with a dial indicator.(j) Methods of checking the indicator for accuracy.(k) Scope of work.(l) Use of the dial indicator for production methods.(m) Care and storage of dial indicators.
22. Measuring, testing and inspecting with pins and wires	<ul style="list-style-type: none">(a) Types and features of pins and wires.(b) Types of work measured and inspected by pins e.g. dovetails, hole location, etc.(c) Types of work measured and inspected by wires e.g. threads, small gears, etc.(d) Calculations for wire and pin work.(e) Methods of holding wires for three wire measurement.(f) Accuracy obtainable.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK III: BENCHWORK PRACTICE UNIT 29: MEASURING, TESTING AND INSPECTING

OPERATIONS	KNOWLEDGE
<p>23. Testing for hardness with a:</p> <p>Rockwell hardness tester Sclerescop Brinell Vickers, etc.</p>	<p>(a) Types and features of hardness testers. (b) Principles of various types of hardness tests. (c) Care and storage of testing equipment. (d) Procedures for hardness testing with various types of equipment. (e) Use of conversion charts e.g. from Rockwell to Brinell, etc. (f) Basic tests for hardness e.g. file, chisel, sound, comparison, etc. (g) Accuracy of hardness tests. (h) The value of hardness tests. (i) Work requiring hardness tests. (j) Procedures in starting tests with material of unknown hardness.</p>
<p>24. Measuring, testing and inspecting surface finish</p>	<p>(a) Types, features and use of precision measuring and testing equipment. (b) Basic methods for testing e.g. sight, fingernail test, etc. (c) Nomenclature for equipment parts. (d) Conception of micro inches. (e) Methods of cleaning lint, dirt, etc., from work piece. (f) Causes of erroneous readings. (g) Standards of surface finish e.g. American standards, etc. (h) Care and storage of equipment. (i) Types of charts, tables, etc. (j) Diagnosis of chart reading. (k) Blueprint reading.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV - DRILL PRESS PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	149
Unit 2. Work Holding Techniques.....	150
Unit 3. Drilling Techniques.....	155
Unit 4. Reaming Techniques.....	160
Unit 5. Boring Techniques.....	162
Unit 6. Miscellaneous Techniques.....	164

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT I: THE MACHINE

OPERATIONS

KNOWLEDGE

- | | |
|----------------------------|--|
| 1. Oiling the machine | <ul style="list-style-type: none">(a) Types, features and functions of machine parts.(b) Kinds, uses and selection of lubricants.(c) Lubrication methods and procedures.(d) Types and features of lubricating equipment e.g. oilers, grease guns, etc.(e) Precautions re over-lubricating motors.(f) Recognition of various types of bearings and lubrication required. |
| 2. Controlling the machine | <ul style="list-style-type: none">(a) Features and functions of primary and secondary controls power, clutch, etc.(b) Types and features of feed trips, stops, etc.(c) Types, features and functions of coolant system controls.(d) Types, features and functions of feed and speed controls. |
| 3. Cleaning the machine | <ul style="list-style-type: none">(a) Types and uses of solvents and cleaners.(b) Cleaning techniques.(c) Frequency of cleaning.(d) Safety practices re Hygiene |
| 4. Adjusting the machine | <ul style="list-style-type: none">(a) Methods of adjusting moving parts.(b) Methods of compensating for wear.(c) Types, features and functions of tools used.(d) Methods of testing and checking the machine.(e) Causes of errors in work.(f) Precautions re replacing guards after adjustments. |

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT I: THE MACHINE

OPERATIONS	KNOWLEDGE
5. Handling and mounting accessories, such as:	(a) Types and features of drill press spindles.
Drill vises	(b) Types and features of special spindles.
Auxiliary tables	(c) Types, features and functions of drill press accessories.
Angle plates	(d) Methods of handling, mounting and removing accessories.
Drill jigs and fixtures	(e) Care and storage of accessories.
Special spindles	(f) Types, features and functions of drill jigs and fixtures.
Cutter bars	(g) Types and features of adapters for accessories.
Tapping attachments	(h) Types and features of holding equipment e.g. bolts, screws, clamps, etc.
High and low speed attachments	(i) Precautions re cleaning, inspecting and mating parts.
Collet attachments	(j) Safety practices re handling.
Floating reamer holder	(k) Types and features of quick acting drill chucks.

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work	(a) Selecting the machine and accessories.
	(b) Accuracy required on the job.
	(c) Type of operation to be performed.
	(d) The scope of various types of drills e.g. sensitive, gang, multiple spindle, plain, etc.
	(e) Rigidity required on job.
	(f) Quantity of parts to be made.
	(g) Types and features of fixtures for odd-shaped work.
	(h) Features and functions of standard work holding equipment.
	(i) Shape and weight of work piece.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Setting up work in a drill vise	<ul style="list-style-type: none"> (a) Types, features and limitations of drill vises. (b) Methods of clamping vise to table. (c) Types and features of drill press tables e.g. fixed, rotary, tilting, etc. (d) Methods of locking table. (e) Methods of centring work under tool. (f) Types and uses of centring equipment e.g. centres, plugs, etc. (g) Methods of truing and testing work. (h) Preparation of work for drilling e.g. layout, etc. (i) Pressure exerted in vise jaws (Mechanics-forces). (j) Methods of protecting work e.g. soft jaws, etc. (k) Precautions re distortion of delicate work. (l) Methods of supporting long work. (m) Precautions re work overhang. Mechanics-moments deflection. (n) Methods of protecting vise bottom. (o) Methods of compensating for wear in vise jaws. (p) Precision setups. (q) Reasons for "packing up" work. (r) Types and uses of indicating tools and equipment. (s) Types and uses of parallels, step jaws, blocks, etc. (t) Types and uses of levelling equipment. (u) Precautions re damage to parallels, vise jaws, etc. (v) Size and kind of vise needed for the job e.g. plain, sine, universal, compensating-jaw, toolmakers, etc. (w) Types, features and functions of production vises e.g. spring loaded, quick acting, hydraulic, air, etc. (x) Need for clean table when setting up work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Setting up work on the drill press table	<ul style="list-style-type: none">(a) Types, features and functions of drill press tables.(b) Types and uses of drill press table fixtures and accessories e.g. stops, clamps, fences, step blocks, etc.(c) Clamping, pressures. Mechanics, moments-forces and friction.(d) Precision setup procedures.(e) Operating precautions.(f) Pressures required in clamping.(g) Types and features of tools used in clamping.(h) Clamping procedures.(i) Types and uses of standard clamps e.g. C-clamps, parallel clamps, finger, "U", goose neck, etc.(j) Types, features and functions of studs and bolts e.g. square head, cut away head, common, etc.(k) Methods of centring work under tool.(l) Methods of testing and levelling table.(m) Methods of locking table.(n) Methods of tilting and locking table.(o) Methods of setting table for precision angle setups.(p) Methods of raising, lowering and clamping table.(q) Special methods used for production setups e.g. quick acting clamps, fences, etc.
4. Setting up work on auxiliary tables	<ul style="list-style-type: none">(a) Types, features and functions of auxiliary tables.(b) Methods of securing auxiliary tables to drill press tables, base, knee, etc.(c) Reasons for using auxiliary tables e.g. large work, production work, precision work, odd-shaped work, work feed, etc.(d) Testing and truing auxiliary tables.(e) Methods of securing work to auxiliary tables.(f) Precautions re use of jacks on extra heavy work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd	<ul style="list-style-type: none"> (g) Types, features and functions of rotary tables. (h) Types, features and functions of compound tables. (i) Types of work machined on rotary and compound tables. (j) Production setups.
5. Setting up work on V-blocks	<ul style="list-style-type: none"> (a) Types, features and functions of V-blocks. (b) Methods of securing V-blocks to table. (c) Types of work requiring V-block mounting. (d) Methods of clamping work in V-blocks. (e) Methods of truing and testing work. (f) Holding procedures. (g) Methods of centring work under tool. (h) Methods of supporting long work. (i) Methods of "setting" up work to provide protection for V-blocks and clamps. (j) Precision setup procedures. (k) Safety practices re anchoring work and V-blocks. (l) Precautions re work overhang. Mechanics - Moments - forces. (m) Use of V-blocks "on end". (n) Types and features of production setups e.g. quick acting clamps, etc.
6. Setting up work on an angle plate	<ul style="list-style-type: none"> (a) Types, features and functions of angle plates, adjustable and fixed. (b) Methods of holding angle plate. (c) Methods of holding work to angle plate. (d) Type of work requiring angle plate mounting. (e) Types and features of clamps for angle plate work. (f) Methods of testing and truing angle plates. (g) Precautions re distortion when clamping work. (h) Precision setups. (i) Types, features and functions of tools and instruments used in precision setups e.g. sine bars, gauge blocks, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd	<ul style="list-style-type: none"> (j) Types, features and uses of stops, fences, guides, etc., used on angle plates. (k) Methods used in heavy work. (l) Methods of centring work under tool. (m) Use of sine bars, gauge blocks, etc. (n) Methods of setting angles on adjustable angle plates e.g. sine angle plates, common compound, etc. (o) Production setups.
7. Setting up work in drill jigs and fixtures	<ul style="list-style-type: none"> (a) Types, features and functions of drill jigs. (b) Types, features and functions of work holding fixtures. (c) Methods of holding jigs and fixtures. (d) Methods of holding work in jigs and fixtures. (e) Types of work requiring jig mounting. (f) Types of work requiring fixture mounting. (g) Methods of testing and truing jigs and fixtures. (h) Methods of centring work under tool. (i) Precautions re distortion of work. (j) Safety practices - smashed toes and fingers, etc. (k) Types and features of drill jig bushings. (l) Types and features of clamping devices used in jigs and fixtures. (m) Preparation of work for mounting in jigs and fixtures. (n) Production setups.
8. Setting up work on a centre	<ul style="list-style-type: none"> (a) Types and features of centres for drill press tables e.g. male, female, etc. (b) Types of work requiring table centre mounting e.g. centring stock for lathe work. (c) Methods of aligning table centre. (d) Methods of holding work. (e) Preparation of work. (f) Safety practices re sharp centres, etc. (g) Operating precautions re marred shanks, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
9. Setting up work on the base (or plates)	<ul style="list-style-type: none"> (a) Reasons for base mounting. (b) Methods of supporting base mounted work. (c) Methods of holding and clamping base mounted work. (d) Methods of testing and truing. (e) Methods of centring work under tool. (f) Setting up procedures. (g) Safety practices re falling bars. (h) Types and features of tools and instruments used for testing and truing work. (i) Types and features of jacks, braces, etc. (j) Precautions re work overhang. (k) Types and features of work holding devices e.g. vises. lathe chucks, jigs and fixtures, etc.
10. Setting up work in the drill chuck or spindle	<ul style="list-style-type: none"> (a) Types of work requiring chucks and spindle mounting. (b) Precautions re distortion of thin walled work. (c) Methods of protecting finished surfaces. (d) Methods of holding work.

BLOCK IV: DRILL PRESS PRACTICE

UNIT 3: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. "Spotting" for drilling. Work held: in a drill vise on the table on an auxiliary table in V-blocks on an angle plate in a jig or fixture on a centre on the base on the column or knee	<ul style="list-style-type: none"> (a) Method of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9, 10. (b) Types, features and functions of spotting tools and drills. (c) Methods and theory of spotting. (d) Speeds and feeds. (e) Cutting compounds. (f) Specifications re accuracy of the job. (g) Type of work requiring spotting. (h) Methods of mounting spotting tools and drills. (i) Methods of controlling size of spot. (j) Precautions re chatter.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 3: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd	<ul style="list-style-type: none"> (k) Methods used in "spotting" on angular, curved and irregular surfaces. (l) Safety practices removal of chuck keys, etc. (m) Precautions - removal of drifts, etc. (n) Care and storage of drill chucks, sockets, sleeves, etc. (o) Methods of measuring "spot" size. (p) Tools and instruments used to measure size and depth of spots. (q) Ideal size for "spot".
2. Centre drilling.	
Work held:	
in a drill vise	(a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9, 10.
on the table	(b) Types of work requiring centre drilling.
on an auxiliary table	(c) Types and features of centre drills.
in V-blocks	(d) Types, features and functions of combination drills and countersinks.
on an angle plate	(e) Types and uses of centre reamers.
in a jig or fixture	(f) Preparation of work for centre drilling.
on a centre	(g) Speeds and feeds.
on the base	(h) Types and uses of lubricants.
on the column or knee	(i) Types, features and functions of centre holes.
	(j) Methods of testing and truing centre holes.
	(k) Precautions re breakage of centre drills e.g. chip removal, feeds, etc.
	(l) Methods of mounting centring tools.
	(m) Methods of controlling depth of centre drills.
	(n) Methods of measuring depth of centre hole.
	(o) Design and size of centre holes.
	(p) Types and features of measuring tools and instruments.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 3: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Drilling a round through-hole in solid stock	(a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 9, and 10.
Work held:	(b) Types, features and functions of drills.
in a vise	(c) Drill design to cut various materials.
on the table	(d) Drilling procedures.
on an auxiliary table	(e) The theory of drilling.
in V-blocks	(f) Drilling nomenclature.
on an angle plate	(g) Preparation of work for drilling.
in a jig or fixture	(h) Methods of holding and driving drills e.g. chuck, sleeve, socket, etc.
on the base	(i) Speeds and feeds.
on the column or knee	(j) Methods of gauging and measuring drills.
	(k) Reasons for "pilot" drilling.
	(l) Coolants and lubricants.
	(m) Chip disposal and control.
	(n) Methods of feeding drill.
	(o) Testing, gauging and measuring drilled hole.
	(p) Types, features and functions of hole measuring tools and instruments.
	(q) Diagnosis and correction of drilling troubles.
	(r) Methods of drilling small deep holes.
	(s) Types, features and functions of low and high speed attachments.
	(t) Methods of drilling partial holes.
	(u) Precautions re break through and spring-back.
	(v) Special methods required in drilling hard materials.
	(w) Safety practices re hot, sharp chips.
	(x) Precautions re broken drills (chip clearance binding drills, etc.)
	(y) Methods of mounting special drills e.g. oil tube, oil hole, etc.
	(z) Methods of "drawing" a drill on centre.
	(aa) Types and features of drill shanks e.g. straight, taper, etc.
	(ab) Types and features of templates for drilling.
	(ac) Pressures required for hand feeding.
	(ad) Methods of "backing up" and "sandwiching" thin work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 3: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd	<ul style="list-style-type: none"> (ae) Precautions re "grabbing" of hand-held work. (af) Precautions re hard spots in metal. (ag) Removal of hard spots e.g. annealing, chipping, etc. (ah) Recognition of dull or poorly ground drills. (ai) Care and storage of drills. (aj) Tools required in operation of the drill press. (ak) Methods of "bedding down" work.
4. Drilling a round, blind, hole in solid stock Work held: in a vise on the table on an auxiliary table in V-blocks on an angle plate in a jig or fixture on a centre on the base on the column or knee	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9 and 10. (b) Methods of controlling depth. (c) Methods of measuring and gauging depth. (d) Types, features and functions of depth measuring tools. (e) Production methods. (f) Chip control and disposal. (g) Application of cutting compounds. (h) Types and features of hole bottoms e.g. flat, conical, formed, etc. (i) Precautions re chip interference when bottoming holes.
5. Drilling a stepped hole Work held: in a drill vise on the table on an auxiliary table in V-blocks on an angle plate in a jig or fixture on the base on the column or knee	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 9 and 10. (b) Types, features and functions of step-drilling tools. (c) Design and use of stepped holes. (d) Procedures in step drilling. (e) Chip control and disposal. (f) Types and features of piloted tools. (g) Size for pilot holes. (h) Precautions re seizing pilots. (i) Methods of measuring and testing stepped holes. (j) Production methods.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 3: DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>6. Counterboring, counter-sinking and spot-facing holes</p> <p>Work held:</p> <ul style="list-style-type: none"> in a drill vise on the table on an auxiliary table on V-blocks on an angle plate in a jig or fixture on a centre on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9 and 10. (b) Types, features and functions of counter-bores, countersinks and spot-facing tools. (c) Counterboring, countersinking and spot-facing techniques. (d) Methods of controlling chatter. (e) Types and uses of combined tools e.g. combination drill and countersink, etc. (f) Methods of controlling depth. (g) Production methods. (h) Cutting speeds and feeds. (i) Precautions re seized pilots. (j) Methods of measuring, testing and gauging.
<p>7. Drilling a partial hole</p> <p>Work held:</p> <ul style="list-style-type: none"> in the drill vise on the table on an auxiliary table on V-blocks on an angle plate in a jig or fixture on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U3, O2, 3, 4, 5, 6, 7, 9 and 10. (b) Drilling procedures. (c) Preparation of work for drilling. (d) Types and uses of bushings for jigs. (e) Types and application of backing pieces. (f) Speeds and feeds. (g) Precautions re drill run out and breakage.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 4: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Reaming a through, parallel hole	(a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 9 and 10.
Work held:	(b) Types, features and functions of reamers e.g. solid, expansion, adjustable, etc.
in a drill vise	(c) The theory of reaming.
on the table	(d) Allowances for reaming.
on an auxiliary table	(e) Preparation of work for reaming.
on V-blocks	(f) Methods of holding and driving reamers.
on an angle plate	(g) Types, features and functions of reamer holders e.g. floating, adjustable, etc.
in a jig or fixture	(h) Types and uses of cutting compounds and coolants.
on the base	(i) Application of coolants and lubricants.
on the column or knee	(j) Speeds and feeds.
	(k) Methods of measuring, testing and gauging holes.
	(l) Care and storage of hole measuring tools and instruments.
	(m) Methods of measuring and testing reamers.
	(n) Care and storage of reamers.
	(o) Diagnosis and correction of reaming troubles.
	(p) Chip disposal and control.
	(q) Methods of starting reamers.
	(r) Specifications of reamers.
	(s) Methods of avoiding distortion in thin walled work.
	(t) Accuracy obtainable.
	(u) Methods of reaming interrupted bores e.g. spiral fluted reamers, etc.
	(v) Precautions re use of reamers e.g. starting, dwell, reversing, seizing, etc.
	(w) Precautions re seizing plug gauges in warm work.
	(x) Safety practices re handling,
	(y) Precautions re oversized and bell mouthed holes.
	(z) Recognition of worn or dull reamers.
	(aa) Knowledge of the correct grind on reamer for material to be cut.
	(ab) Methods of reaming in alignment.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 4: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Reaming a blind parallel hole</p> <p>Work held:</p> <ul style="list-style-type: none"> in a drill vise on the table on an auxiliary table on V-blocks on an angle plate in a jig or fixture on a centre on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9 and 10. (b) Types, features and functions of blind hole reamers. (c) Reaming procedures. (d) Allowances in depth for reaming blind holes. (e) Methods of gauging and measuring depth. (f) Types, features and functions of depth measuring tools and instruments. (g) Chip control and disposal. (h) Production methods. (i) Precautions re bottoming. (j) Methods of reaming a stepped hole. (k) Types, features and functions of production reamers.
<p>3. Reaming a through tapered hole.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a drill vise on the table on an auxiliary table on V-blocks on an angle plate in a jig or fixture on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 9, and 10. (b) Types, features and functions of tapered reamers, roughing and finishing. (c) Allowances for taper reaming. (d) Methods of testing and gauging tapered holes. (e) Methods of testing and gauging taper reamers. (f) Taper reamer nomenclature. (g) Chip control and disposal. (h) Reaming procedures. (i) Speeds and feeds. (j) Methods of taper reaming in alignment. (k) Preparation of work for taper reaming. (l) Prevention and correction of chatter. (m) Precautions re "binding" of reamers. (n) Care and storage of taper reamers. (o) Diagnosis and correction of taper reaming troubles. (p) Precautions re gauging warm work. (q) Precautions re chip interference.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 4: REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Reaming a blind tapered hole.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a drill vise on the table on an auxiliary table on V-blocks on an angle plate in a jig or fixture on a centre on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 5, 6, 7, 8, 9 and 10. (b) Methods of measuring, testing and gauging blind tapered holes. (c) Chip control and disposal. (d) Types and uses of blind tapered holes. (e) Precautions re chips in hole bottom. (f) Precautions re bottoming. (g) Production methods. (h) Types and uses of production reamers e.g. stepped, etc.
<p>5. Reaming a partial hole</p> <p>Work held:</p> <ul style="list-style-type: none"> in a drill vise on the table on an auxiliary table on an angle plate in a jig or fixture on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 7, 8, 9 and 10. (b) Types and uses of guide bushings. (c) Methods of using "backing pieces" or blocks. (d) Method of nesting i.e. doing 2 or more at one time. (e) Types of reamers suitable for partial hole reaming.

BLOCK IV: DRILL PRESS PRACTICE

UNIT 5: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Boring a through hole</p> <p>Work held:</p> <ul style="list-style-type: none"> in a vise on the table on an auxiliary table on an angle plate in a jig or fixture on the base on the column or knee 	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 6, 7, 9 and 10. (b) Reasons for boring in the drill press. (c) Boring procedures. (d) Types, features and uses of boring bars, heads and tools. (e) Methods of mounting tools. (f) Speeds and feeds. (g) Types and uses of cutting compounds. (h) Methods of measuring bores. (i) Types, features and functions of bore measuring instruments.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 5: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd	<ul style="list-style-type: none"> (j) Care and storage of instruments. (k) Precautions re gauging warm work. (l) Precautions re chatter. (m) Production methods. (n) Chip control and disposal. (o) Surface finish obtainable. (p) Accuracy obtainable. (q) Precautions re interrupted cuts. (r) Types and uses of pilot bushings. (s) Safety practices re rotating cutters. (t) Methods of measuring speed. (u) Types and uses of offset boring heads, fly cutter bars, etc. (v) Methods of adjusting tools. (w) Methods of measuring obstructed bores. (x) Preparation of work for boring. (y) Methods of boring partial holes. (z) Methods of measuring partial holes. (aa) Methods of boring stepped holes.
2. Boring a blind hole.	<ul style="list-style-type: none"> (a) Methods of mounting work as B5, U2, O2, 3, 4, 6, 7, 9 and 10.
Work held:	<ul style="list-style-type: none"> (b) Selection of tools.
in a drill vise	<ul style="list-style-type: none"> (c) Methods of controlling depth.
on the table	<ul style="list-style-type: none"> (d) Precautions re bottoming.
on an auxiliary table	<ul style="list-style-type: none"> (e) Methods of measuring and gauging depth.
on an angle plate	<ul style="list-style-type: none"> (f) Boring procedures.
in a jig or fixture	<ul style="list-style-type: none"> (g) Types and uses of depth measuring instruments.
on the base	<ul style="list-style-type: none"> (h) Chip control and disposal.
on the column or knee	<ul style="list-style-type: none"> (i) Safety practices. (j) Precautions re chatter. (k) Preparation of work for boring. (l) Speeds and feeds. (m) Precautions re interrupted cuts.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 5: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Circle cutting (trepanning)</p> <p>Work held: in a vise on the table on an auxiliary table in a jig or fixture on the base on the column or knee</p>	<p>(a) Methods of mounting work as B5, U2, O2, 3, 4, 7, 9 and 10.</p> <p>(b) Types, features and functions of circle cutting tools e.g. fly cutters, hole saws, single and multiple spur tools, etc.</p> <p>(c) Reasons for trepanning.</p> <p>(d) Methods of measuring trepanned grooves and holes.</p> <p>(e) Methods of removing cores.</p> <p>(f) Precautions re "break through".</p> <p>(g) Speeds and feeds.</p> <p>(h) Precautions re tool angles.</p> <p>(i) Safety practices re rotating cutters.</p> <p>(j) Production methods.</p> <p>(k) Application and uses of cutting compounds.</p> <p>(l) Methods of deburring.</p> <p>(m) Safety practices re sharp fins.</p> <p>(n) Cutting angles for circle cutting tools for "core saved" or "bore saved".</p> <p>(o) Types, features and functions of washer cutters.</p> <p>(p) Preparation of work e.g. pilot holes, etc.</p> <p>(q) Hole sawing procedures e.g. removal of cuttings, etc.</p>

BLOCK IV: DRILL PRESS PRACTICE

UNIT 6: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Honing a hole.</p> <p>Work held: in a vise on the table on an auxiliary table on a jig or fixture on the column or knee</p>	<p>(a) Methods of mounting work as B5, U2, O2, 3, 4, 7 and 10.</p> <p>(b) Reasons for honing in the drill press.</p> <p>(c) Speeds and feeds.</p> <p>(d) Types and features of hones.</p> <p>(e) Methods of mounting hones and hone heads.</p> <p>(f) Precautions re "bell-mouthing".</p> <p>(g) Surface finish obtainable.</p> <p>(h) Methods of testing and measuring honed surfaces.</p> <p>(i) Methods of testing and gauging holes.</p> <p>(j) Allowances for honing.</p> <p>(k) Preparation of work for honing.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IV: DRILL PRESS PRACTICE

UNIT 6: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Lapping a cylinder.</p> <p>Work held: in the drill chuck or spindle</p>	<p>(a) Methods of mounting work as B1, U2, 011. (b) Methods of holding laps. (c) Lapping procedures. (d) Methods of adjusting laps. (e) Recognition of worn or damaged lap. (f) Methods of applying lapping compounds. (g) Reasons for lapping in the drill press. (h) Allowances for lapping. (i) Methods of handling lapped parts e.g. care and storage.</p>
<p>3. Polishing.</p> <p>Work held: in the drill chuck or spindle</p>	<p>(a) Methods of mounting work as B5, 02, 011. (b) Reasons for polishing in a drill press. (c) Methods of mounting and holding abrasive cloth and papers. (d) Types of work requiring polishing. (e) Speeds for polishing. (f) Polishing procedures. (g) Allowances for polishing. (h) Types and features of lubricants. (i) Types, features and classification of abrasives for polishing. (j) Types and features of polishing devices e.g. sticks, pads, etc. (k) Methods of applying pressure. (l) Surface finish obtainable. (m) Methods of measuring surface, finish. (n) Methods of polishing contours. (o) Methods of tearing and cutting abrasive cloth e.g. direction. (p) Precautions re rounding corners and changing contour shapes. (q) Safety practices re pinched fingers. (r) Safety practices re flying particles (goggles).</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V - MILLING MACHINE PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine	167
Unit 2. Work Holding Techniques	168
Unit 3. Tool Holding Techniques	170
Unit 4. Flat Surface Milling Techniques	174
Unit 5. Formed Surface Milling Techniques	177
Unit 6. Contour Milling Techniques	179
Unit 7. Keyway and Spline Milling Techniques	179
Unit 8. Dovetail Milling Techniques	181
Unit 9. T-Slot Milling Techniques	181
Unit 10. Gear Milling Techniques	182
Unit 11. Cam Milling Techniques	186
Unit 12. Helical and Spiral Milling Techniques	187
Unit 13. Miscellaneous Techniques	189

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS

KNOWLEDGE

- | | |
|----------------------------|---|
| 1. Oiling the machine | (a) Features and functions of milling machine parts.
(b) Kinds and selection of suitable lubricant.
(c) Lubrication methods.
(d) Frequency of lubrication.
(e) Types of lubrication equipment.
(f) Methods of checking automatic lubrication equipment.
(g) Types and features of oil filters.
(h) Statistical control of lubricating.
Use of chart, etc. |
| 2. Controlling the machine | (a) Operating precautions.
(b) Features and functions of control mechanisms.
(c) Types and features of rapid feed mechanisms.
(d) Types and features of machine clutches.
(e) The use of "colour dynamics".
(f) The importance of operator's manual.
(g) Safety practices, e.g. check points before starting. |
| 3. Cleaning the machine | (a) Types and uses of solvents and cleaners.
(b) Cleaning techniques.
(c) Safety practices - Hygiene.
(d) Precaution re solvent in coolant tank.
(e) Precautions re compressed air. |
| 4. Adjusting the machine | (a) Methods of adjusting moving parts.
(b) Methods of compensating for wear.
(c) Procedures and equipment for testing machines.
(d) Causes of errors.
(e) Types and features of tools used in machine adjustment.
(f) Types, features and functions of tools used e.g. mechanics tools, speed indicators, etc.
(g) Allowances for fits in stationary and moving parts.
(h) Methods of removing and replacing shear pins. |

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
<p>5. Handling and mounting the following accessories:</p> <p>cutter arbors. vertical milling attachments. slotting attachments. rack cutting attachments. indexing. vise. boring bars. rotary table. spiral milling attachments. jigs and fixtures. index bases. auxiliary tables.</p>	<p>(a) Types, features and functions of standard milling machine spindle noses. (b) Methods of handling and mounting accessories. (c) Care of machine and accessories. (d) Accuracy and limitations of milling machine accessories. (e) Precautions re cleaning mating parts. (f) Safety practices - Handling. (g) Types and features of hold-down bolts and clamps. (h) Methods of driving attachments. (i) Types and features of draw-in bolts. (j) Methods of mounting arbors and adapters. (k) Types and features of cutter arbors. (l) Methods of keying cutter to arbor. (m) Methods of checking run out on cutter arbors. (n) Methods of driving cutter arbors. (o) Types and features of milling machine vises e.g. plain, swivel, etc. (p) Types and features of standard vertical milling machine attachments. (q) Types of high speed vertical milling attachments.</p>

BLOCK V: MILLING MACHINE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Selecting the method of holding work</p>	<p>(a) Selecting the machine and accessories. (b) Types of operations to be performed. (c) Accuracy required on the job. (d) Type of work piece (fragility, etc.). (e) Weight, size and shape of work piece. (f) Number of parts to be made. (g) Capacity of machine. (h) Method of locating accessories on the table. (i) Types and features of hold-down clamps. (j) Types and features of T-slot bolts. (k) Types and features of jacks.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Setting up work in vises, such as:</p> <p> plain vise</p> <p> flanged vise</p> <p> swivel base vise</p> <p> universal vise</p>	<p>(a) Types, features and functions of vises.</p> <p>(b) Limitations of vises.</p> <p>(c) Methods of locating work in vises.</p> <p>(d) Methods of attaching vises to table of machine.</p> <p>(e) Methods of aligning vises.</p> <p>(f) Types and uses of indicating equipment.</p> <p>(g) Methods of protecting work in vises.</p> <p>(h) Types and features of soft vise jaws.</p> <p>(i) Types and features of soft jaw liners.</p>
<p>3. Setting up work on</p> <p> the table</p> <p> auxiliary tables, etc.</p>	<p>(a) Types and features of table mounted fixtures.</p> <p>(b) Types of work requiring table mounting.</p> <p>(c) Procedures used in truing up, indicating, etc.</p> <p>(d) Setup procedures.</p> <p>(e) Types and operation of lifting equipment.</p> <p>(f) Safety practices re clearances, etc.</p>
<p>4. Setting up work on:</p> <p> indexing centres</p> <p> single dial index centres</p> <p> universal index centres</p> <p> plain index centres</p>	<p>(a) Types and features of indexing centres.</p> <p>(b) Types of work usually mounted on centres.</p> <p>(c) Work requiring indexing.</p> <p>(d) Methods of driving universal index centres</p> <p>(e) Methods of calculating indexing cycle.</p> <p>(f) Types and features of index plates.</p> <p>(g) Methods of indexing.</p>
<p>5. Setting up work on rotary tables such as:</p> <p> hand feed rotary table</p> <p> power feed rotary table</p>	<p>(a) Types and features of rotary tables.</p> <p>(b) Methods of attaching rotary tables to the machine.</p> <p>(c) Types of work requiring mounting on rotary tables.</p> <p>(d) Methods of mounting work on rotary tables.</p> <p>(e) Methods of graduating rotary tables.</p> <p>(f) Methods of driving power-feed rotary tables.</p> <p>(g) Types and features of gear boxes for rotary table.</p> <p>(h) Methods of truing work on rotary table.</p> <p>(i) Types and features of indicating equipment.</p> <p>(j) Care and maintenance of rotary tables.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Setting up work on an angle plate	<ul style="list-style-type: none"> (a) Types and features of angle plates. (b) Methods of attaching angle plates to the table. (c) Types of work requiring angle plate mounting. (d) Methods of setting up and truing work on angle plates. (e) Types and features of indicating equipment. (f) Care and maintenance of angle plates. (g) Methods of attaching work to angle plate.
7. Setting up work on a fixture	<ul style="list-style-type: none"> (a) Types and features of milling fixtures. (b) Methods of attaching fixtures to the table. (c) Design and features of fixture clamps. (d) Reasons for using fixture. (e) Methods of locating work in a fixture. (f) Care and maintenance of milling fixtures.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 3: TOOL HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Mounting plain milling cutters, such as: light-duty plain cutters heavy-duty plain cutters	<ul style="list-style-type: none"> (a) Types and features of arbors suitable for mounting plain or slot mills. (b) Methods of keying cutter to arbor. (c) Methods of checking cutter for runout. (d) Types and features of indexing equipment. (e) Milling cutter nomenclature. (f) Types and features of spiral mills. (g) Types of work requiring heavy duty milling cutters. (h) Types and features of helical mills. (i) Speeds and feeds for plain milling. (j) Materials used in manufacture.
2. Mounting side milling cutters, such as: (a) single side milling cutters (b) full side milling cutters	<ul style="list-style-type: none"> (a) Types and features of side milling cutters. (b) Methods of mounting side milling cutters. (c) Types of work requiring side mills. (d) Methods of mounting interlocking cutters. (e) Types and features of collars and shims. (f) Limitation of side milling cutters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 3: TOOL HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	(g) Methods of regulating width between cutters, straddle milling.
(c) stagger tooth side mills	(h) Methods of compensating for wear or sharpening.
(d) interlocking slotting cutters	(i) Speeds and feeds for side milling.
	(j) Materials used in manufacture.
3. Mounting metal slitting saws, such as:	(a) Types and features of metal slitting saws.
side relieved saws	(b) Types and features of teeth used in slitting saws.
form relieved saws	(c) Methods used to prevent clogging of teeth.
	(d) Speeds and feeds for metal slitting.
	(e) Methods of driving slitting saws.
	(f) Design of flanges for use with slitting saws.
	(g) Materials used in manufacture.
4. Mounting angle milling cutters, such as:	(a) Design and features of angle milling cutters.
single angle cutters	(b) Types of work requiring angle cutters.
double angle cutters	(c) Standard angles used in angle cutters.
	(d) Methods of driving angle cutters.
	(e) Types or arbors used with angle cutters.
	(f) Materials used in manufacture.
5. Mounting formed milling cutters, such as:	(a) Design and features of formed profile cutters, solid, inserted teeth.
formed profile cutters	(b) Methods of controlling shape of formed profile teeth.
form relieved cutters	(c) Types of work requiring formed profile cutters.
	(d) Design and features of gauges for formed profiles.
	(e) Design and features of form relieved cutters.
	(f) Uses and limitation of each cutter type.
	(g) Materials used in manufacture.
6. Mounting end milling cutters, such as:	(a) Design and features of taper shank end mills.
taper shank end mills	(b) Standard multiple tooth end mills.
	(c) Standard two-lip end mills.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 3: TOOL HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd. straight shank end mills shell end mills	<ul style="list-style-type: none"> (d) Types of work requiring end mills. (e) Types of teeth used e.g. straight or helical. (f) Limitations of standard end mills. (g) Standard taper shanks. (h) Standard straight shanks. (i) Types and features of shell end mills. (j) Methods of mounting shell end mills. (k) Standard taper sleeves. (l) Shell end mill arbors. (m) Speeds and feeds for end milling cutters. (n) Types of work requiring shell end mills. (o) Methods of driving shell end mills. (p) Types of materials used in manufacture of end mills.
7. Mounting T-slot milling cutters	<ul style="list-style-type: none"> (a) Design and features of T-slot cutters. (b) Methods of driving T-slot cutters. (c) Standard shanks used on T-slot cutters. (d) Speeds and feeds for milling T-slots. (e) Methods of mounting large T-slot cutters e.g. separate shanks.
8. Mounting woodruff key-seat cutters	<ul style="list-style-type: none"> (a) Design and features of woodruff key seat cutters. (b) Limitations of woodruff key seat cutters. (c) Methods of driving woodruff key seat cutters. (d) Types of arbors used for large key seat cutters. (e) Speeds and feeds for key seating.
9. Mounting fly cutters	<ul style="list-style-type: none"> (a) Design of arbor for fly cutters. (b) Reasons for using fly cutters. (c) Limitation of fly cutters. (d) Speeds and feeds for fly cutting. (e) Materials used for fly cutters. (f) Methods of form relieving fly cutters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 3: TOOL HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
10. Mounting inserted tooth milling cutters, such as: face milling cutters inserted tooth slab mills	(a) Design and features of inserted tooth milling cutters. (b) Types of cutters usually having inserted teeth. (c) Reasons for using inserted teeth. (d) Materials used in cutter teeth. (e) Design of light duty and heavy duty face mills. (f) Speeds and feeds for face milling. (g) Advantages of face milling. (h) Design and features of inserted tooth slab mills. (i) Methods of holding teeth in cutter body. (j) Types, features and functions of chip breakers.
11. Mounting standard cutter arbors and adapters	(a) Design and features of standard cutter arbors. (b) Types of cutters usually arbor mounted. (c) Standard milling machine spindle tapers. (d) Self holding and self releasing tapers. (e) Standard shell end mill adapters. (f) Types of face mill adapters. (g) Types of threaded end arbors e.g. for shank type single angle cutters. (h) Types of tang drive adapters. (i) Types and features of split collets. (j) Design and features of draw in bolts. (k) Types and features of spring chucks. (l) Methods of checking run out on arbors and adapters. (m) Methods of supporting outer ends of arbors. (n) Types and uses of spacing collars. (o) Types of intermediate arbor supports. (p) Types and features of extension adapters. (q) Precautions re clean mating surfaces on cutters and collars. (r) Precaution re tightening of arbor nut without support.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 4: FLAT SURFACE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Milling a flat surface, horizontal or vertical.	(a) Methods of mounting work as B6, U2, O2, 3, 5.
Work held:	(b) Selection of type of cutter for horizontal or vertical flat surfacing.
in the vise	(c) Types, features and functions of slot milling cutters.
on the table	(d) Types, features and functions of face milling cutters.
on an angle plate	(e) Methods of mounting slot mills.
on an auxiliary table	(f) Methods of mounting face mills.
on a fixture	(g) Selection of cutting speeds and feeds.
on a rotary table	(h) Methods of measuring speed.
	(i) Methods of selecting speed.
	(j) Methods of gauging depth of cut.
	(k) Surface finish obtainable.
	(l) Methods of chip control and disposal.
	(m) Milling procedures.
	(n) Speeds and feeds for rough and finish cuts.
	(o) Methods of preventing chatter.
	(p) Calculating machining time.
	(q) Methods of taking cut.
	(r) Maximum cut obtainable.
	(s) Methods of eliminating backlash.
	(t) Types and features of cutting lubricants.
	(u) Types and features of instruments for checking surfaces.
	(v) Methods of applying cutting lubricants.
	(w) Methods of recognizing dull cutters.
	(x) Methods of milling to a shoulder.
	(y) Methods of controlling length of feed travel e.g. stops, etc.
	(z) Precautions re clearance around job.
	aa) Safety practices - care re loose clothing and ties.
	(ab) Methods of extra support for extra heavy cuts.
	(ac) Method of determining direction of feed.
	(ad) Methods of checking for distortion when clamping work.
	(ae) Methods of testing and gauging vertical surfaces.
	(af) Methods of gauging cut when working blind.
	(ag) Methods of finishing cuts e.g. run out, etc.
	(ah) Methods of locking tables against thrust of cut.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 4: FLAT SURFACE MILLING TECHNIQUES

OPERATIONS

KNOWLEDGE

- | | |
|---|--|
| <p>1. Cont'd.</p> | <p>(ai) Methods of feeding work on rotary tables.
(aj) Types, features and function of Standard parallels.</p> |
| <p>2. Milling a flat surface at an angle.</p> <p>Work held:
in a vise
on the table
on an angle plate
in a fixture
on a rotary table
on an auxiliary table</p> | <p>(a) Methods of mounting work as B6, U2, O2, 3, 5.
(b) Methods of supporting work on an angle.
(c) Methods of gauging and testing angular surfaces.
(d) Methods of setting up work to a layout.
(e) Types, features and functions of Sine Bars.
(f) Types, features and functions of protractors and angle gauges.
(g) Methods of preventing shift of work during milling.
(h) Methods of checking and testing angular surfaces.
(i) Types, features and functions of Universal and Sine vises.
(j) Methods of reading vernier protractors.
(k) Types and features of fixtures for production milling angles.
(l) Methods of removing burrs.
(m) Methods of setup for compound angles.
(n) Calculation for angles.
(o) Methods of preparing cast iron for milling.
(p) Tolerance to which angles can be milled.
(q) Methods of rotating table of machine.
(r) Types and features of angle parallels.</p> |
| <p>3. Milling a flat surface, horizontal or vertical.</p> <p>Work held:
on centres
on universal index centres</p> | <p>(a) Methods of mounting work as B6, U2, O4.
(b) Reasons for mounting on centres.
(c) Types of work requiring centre mounting.
(d) Methods of indexing work.
(e) Methods of roughing and finishing.
(f) Methods of testing surfaces.
(g) Methods of checking indexing.
(h) Production methods.
(i) Types, features and functions of cutting lubricants.
(j) Methods of applying lubricants.
(k) Methods of removing burrs.
(l) Diagnosis of milling troubles e.g. chatter, etc.
(m) Methods of preventing chatter.</p> |

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 4: FLAT SURFACE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (n) Chip disposal methods. (o) Setting stops for length of cut. (p) Speeds and feeds for milling on centres. (q) Safety practices re hands in cutter, etc.
4. Milling a flat surface at an angle.	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Reasons for mounting work on centres. (c) Types of work requiring centre mounting. (d) Standard tapers. (e) Methods of measuring flat tapers. (f) Tolerances obtainable. (g) Types and features of tools used for measuring tapers. (h) Methods of setting over table. (i) Methods of calculating angle. (j) Methods of applying cutting lubricants. (k) Calculating time for milling. (l) Types and features of End Milling cutters. (m) Types and features of Vertical Milling attachments. (n) Types and features of standard sleeves for end mills. (o) Methods of preventing cutter slippage in sleeves. (p) Types and features of draw-in bolts for end mills. (q) Methods of driving end mills.
Work held: on centres on universal index centres	
5. Milling a flat surface, horizontal or vertical, to a shoulder.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 5. (b) Types of work requiring milling to a shoulder. (c) Methods of adjusting table stops when milling to a shoulder. (d) Methods of approaching shoulder. (e) Methods of chip disposal in confined spaces. (f) Tolerances obtainable. (g) Methods of applying cutting lubricants. (h) Procedures used when milling to a shoulder. (i) Methods of milling in a recess. (j) Methods used to determine a dull cutter. (k) Production methods e.g. fixtures, etc. (l) Tools used for depth measurement.
Work held: in a vise on the table on an angle plate in a fixture on a rotary table on an auxiliary table	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 4: FLAT SURFACE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Cont'd.	<ul style="list-style-type: none"> (m) Precaution re clearance of tool and work in fixture. (n) Methods of supporting long work to prevent spring. (o) Methods of Testing for squareness. (p) Methods of testing end mills for runout.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 5: FORMED SURFACE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Milling an external curved surface. Work held: in a vise on the table on an angle plate on an auxiliary table on a fixture on a rotary table on index centres	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 4, 5, 6 and 7. (b) Types and features of cutters for formed surfaces. (c) Methods of checking and testing. (d) Care and storage of templates. (e) Methods of roughing down. (f) Methods of finishing. (g) Design of cutters for formed surfaces. (h) Uses for formed surfaces. (i) Feeds and speeds for milling formed surfaces. (j) Coolants for milling. (k) Methods of checking and testing templates for formed surfaces. (l) Production methods. (m) Methods of using rotary table for forming with a plain cutter. (n) Capacity of machine. (o) Methods of setting machine for forming cuts. (p) Diagnosis and correction of chatter. (q) Types, features and functions of cutting oils. (r) Surface finish obtainable. (s) Ways of recognizing worn cutters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 5: FORMED SURFACE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Milling an external irregular surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a vise on the table on an angle plate on an auxiliary table on a fixture on a rotary table on index centres 	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 4, 5, 6, 7. (b) Uses for external irregular surfaces. (c) Procedures for roughing out. (d) Methods of milling to a layout. (e) Methods of "gang" milling. (f) Methods of using universal head with end mills. (g) Types and features of end mills for curved surfaces. (h) Methods of checking irregular surfaces. (i) Types and features of templates for checking irregular surfaces. (j) Features and functions of the shadowgraph. (k) Methods of applying coolants. (l) Methods of chip disposal. (m) Maximum amount of stock that can be removed. (n) Speeds and feeds for milling irregular surfaces. (o) Types of extra overarm supports. (p) Types and features of overarm support bushings.
<p>3. Milling a helical or spiral groove.</p> <p>Work held:</p> <ul style="list-style-type: none"> on index centres 	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Types and features of helical and spiral grooves. (c) Methods of preparing work for milling. (d) Methods of driving work for milling helix. (e) Calculation of lead in helix or spiral. (f) Methods of driving the table feed to obtain leads. (g) Types and features of taper attachments. (h) Types and features of fluting cutters. (i) Types and features of form end mills. (j) Milling to a layout. (k) Layout procedures. (l) Methods of checking and testing formed helical and spiral grooves.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 6: CONTOUR MILLING TECHNIQUES

OPERATIONS

KNOWLEDGE

1. Milling an irregular shape with a form milling cutter.

Work held:

- in the vise
- on the table
- on an angle plate
- on an auxiliary table
- on a fixture
- on a rotary table

- (a) Methods of mounting work as B6, U2, O2, 3, 5, 6, 7.
- (b) Types and features of regular and irregular shapes and contours.
- (c) Methods of gang milling.
- (d) Method of aligning cutter with work.
- (e) Types and features of form milling cutters.
- (f) Milling to a layout.
- (g) Method of preparing work for milling.
- (h) Methods of giving arbor adequate support.
- (i) Types and features of coolants.
- (j) Methods of applying coolants and lubricants.
- (k) Cutting speeds and feeds for contour milling.
- (l) Methods of checking and testing contours.
- (m) Operating precautions re chatter.
- (n) Methods of chip control and disposal.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 7: KEYWAY AND SPLINE MILLING TECHNIQUES

OPERATIONS

KNOWLEDGE

1. Milling a keyway in a shaft.

Work held:

- in a vise
- on the table
- on index centres
- on a fixture

- (a) Methods of mounting work as B6, U2, O2, 3, 4, 7.
- (b) Types and features of milled keyways.
- (c) Reasons for milling keyways.
- (d) Methods of laying out keyways.
- (e) Methods of aligning work to cutter.
- (f) Method of feeding work into cutter.
- (g) Method of testing and measuring keyways.
- (h) Method of setting depth of cut.
- (i) Methods of applying coolants and lubricants.
- (j) Method of ending keyways.
- (k) Speeds and feeds for milling keyways.
- (l) Types and features of "woodruff" keyseat cutters.
- (m) Reasons for using woodruff keys.
- (n) Methods of preparing work for cutting keyways.
- (o) Methods of measuring and testing woodruff keyseats.
- (p) Methods of holding and driving woodruff keyseat cutters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 7: KEYWAY AND SPLINE MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (q) Methods of locating woodruff keyseat cutters. (r) Calculations for size of key necessary. (s) Precautions re clogging of cutter in deep keyways. (t) Methods of applying coolant. (u) Types and features of coolants used in milling. (v) Methods of chip control and disposal. (w) Types and features of keyway gauges.
2. Milling a spline	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4, 7. (b) Types and features of milled splines. (c) Reasons for milling splines. (d) Methods of preparing work for milling splines. (e) Layout procedures. (f) Types and features of spline milling cutters. (g) Methods of measuring and testing splines. (h) Methods of indexing work. (i) Methods of preventing backlash when cutting. (j) Spline milling procedures. (k) Selection of cutter speed for spline milling. (l) Types and features of instruments used in spline layout. (m) Methods of locating cutter over work. (n) Different methods used in milling splines. (o) Types, features and functions of spline milling fixtures. (p) Feeds used in spline milling.
Work held: on index centres on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 8: DOVETAIL MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Milling a male or female dovetail.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a vise on the table on an angle plate on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 6, 7. (b) Types, features and functions of dovetails. (c) Preparation of work for milling dovetails. (d) Types and features of cutters used when milling dovetails. (e) Types and features of angular milling cutters. (f) Speeds and feeds for milling dovetails. (g) Methods of mounting cutters e.g. arbour mounted or vertical spindle mounted. (h) Methods of measuring and testing dovetails. (i) Calculations for roll measurements. (j) Milling to a layout. (k) Surface finish obtainable. (l) Methods of fitting dovetails. (m) Types, features and care of indicating equipment. (n) High spot indicators. (o) Roughing and finishing cuts required. (p) Types and application of cutting compounds. (q) Operating precautions re wedging. (r) Operating precautions re chip interference. (s) Operating precautions re climb milling. (t) Production methods.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 9: T-SLOT MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Milling a T-slot.</p> <p>Work held:</p> <ul style="list-style-type: none"> in a vise on the table on index centres on a rotary table on an angle plate on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 4, 5, 6, 7. (b) Preparation of work for milling a T-slot. (c) Types, features and functions of T-slots. (d) Types and features of T-slot cutters. (e) Types and features of end mills. (f) Speeds and feeds for end milling. (g) Speeds and feeds for T-slot milling. (h) Milling procedures. (i) Methods of checking and testing T-slots. (j) Methods of letting in T-slot cutter into blind T-slot. (k) Methods of holding T-slot cutters. (l) Methods of laying out T-slots. (m) Methods of feeding rotary table when cutting circular T-slots.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 9: T-SLOT MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (n) Standard T-slots. (o) Methods of chip control and disposal in closed slot. (p) Operating precautions re chip interference.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 10: GEAR MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Milling a gear. Work held: on index centres on a fixture	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, 04, 7. (b) Spur gear nomenclature. (c) Types, features and functions of gears. (d) Standard gear teeth. (e) Spur gear calculations. (f) Materials suitable for gears. (g) Methods of preparing work. (h) Methods of measuring gear teeth, e.g. gear tooth vernier. (i) Types, features and care of gear tooth verniers. (j) Methods of setting up work for milling. (k) Methods of centring cutter on work. (l) Types, features and selection of spur gear cutters. (m) Design of gear tooth cutters. (n) Methods of indexing work. (o) Indexing calculations. (p) Types and features of indexing centres and fixtures. (q) Reasons for milling gear teeth. (r) Methods of mounting gear tooth cutters. (s) Accuracy required. (t) Methods of eliminating chatter. (u) Surface finish obtainable. (v) Methods of "stocking out" large gear teeth. (w) Cutting speeds for milling. (x) Feeds required in milling gear teeth. (y) Methods of mounting and removing work from mandrels. (z) Milling procedures. (aa) Precautions re work slippage on mandrel. (ab) Methods of obtaining correct tooth depth. (ac) Standard involute gear cutter series.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 10: GEAR MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (ad) Types, features and functions of suitable cutting lubricants for gear milling. (ae) Methods of applying cutting compounds. (af) Diagnosis and correction of milling errors. (ag) Methods of locking lathe dogs on index centres. (ah) Types and features of fly cutters suitable for gear cutting. (ai) Methods of finishing gears, deburring, etc.
2. Milling a rack.	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 4, 6, 7. (b) Uses for racks. (c) Preparation of work for cutting rack teeth. (d) Design of rack teeth. (e) Methods of indexing work for cutting rack teeth. (f) Calculations for depth of teeth. (g) Calculation for pitch of rack teeth. (h) Types and features of cutters for forming rack teeth. (i) Types and features of "stocking out" cutters. (j) Gear Tooth nomenclature. (k) Design and features of tools for measuring rack teeth. (l) Methods of using tables for calculation of rack teeth. (m) Tolerances allowable. (n) Methods of setting up work for cutting rack teeth. (o) Methods of recentering cutter on long racks. (p) Types and features of rack cutting attachments. (q) Principles of linear indexing. (r) Methods of determining where to start cut. (s) Diagnosis and correction of milling troubles. (t) Types and features of fly cutters for cutting rack teeth. (u) Calculation for linear indexing.

Work held:

in a vise
on the table
on an angle plate
on an auxiliary
table
on a fixture
on index centres

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 10: GEAR MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Milling a bevel gear. Work held: on index centres	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Preparations of blank for milling. (c) Design, features and functions of bevel gears. (d) Calculation of face angle on bevel gear. (e) Calculation of cutting angle on bevel gear. (f) Calculation of pitch cone angle of bevel gears. (g) Methods of setting index centre at correct angle. (h) Types, features and functions of cutters for bevel gears. (i) Calculations for roll on gear teeth. (j) Methods of centring blank on cutters. (k) Milling procedures. (l) Calculations for indexing gear blank. (m) Direction of rotation of cutter to obtain correct thrust. (n) Methods of indexing work. (o) Methods of mounting bevel gear cutters. (p) Methods of calculating depth of cut. (q) Methods used to select correct cutter. (r) Accuracy obtainable. (s) Methods of measuring and testing bevel gear teeth. (t) Methods of determining setover. (u) Methods of gashing teeth. (v) Diagnosis and correction of indexing and milling errors. (w) Methods of finishing gears, lapping, etc. (x) Methods of applying coolants and lubricants. (y) Milling speeds and feeds. (z) Amount of stock that can be removed in one cut. (aa) Precautions re work slippage on mandrel. (ab) Methods of using standard involute cutter to cut bevel teeth.
4. Gashing a worm wheel. Work held: on index centres	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Types, features and functions of worm wheels. (c) Methods of selecting cutter for gashing teeth. (d) Methods of determining angle to set table. (e) Method of determining hand of cut e.g. right or left.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 10: GEAR MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (f) Calculation of depth of cut. (g) Amount of material left for finishing. (h) Method of feeding cutter into work. (i) Milling speed. (j) Method of indexing blank for each cut. (k) Methods of applying coolants. (l) Milling procedures. (m) Types and features of cutters for gashing blanks. (n) Types and features of fly cutters.
5. Hobbing a worm wheel.	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Types, features and functions of hobs. (c) Worm gear nomenclature and design. (d) Worm gear calculations. (e) Methods of preparing blank for hobbing e.g. gashing. (f) Methods of mounting work free from index head. (g) Methods of mounting hobs. (h) Methods of centring blank on hob. (i) Methods of feeding work into hob. (j) Hobbing procedures. (k) Speeds for hobbing. (l) Amount of infeed required. (m) Methods of determining correct depth of cut. (n) Methods of measuring and testing worm wheels. (o) Accuracy obtainable. (p) Methods of starting cuts. (q) Precautions re thrust of hob on blank. (r) Precautions re lubrication of mandrel centre holes. (s) Materials used in manufacture of worm wheels. (t) Reasons for hobbing worm wheels. (u) Types and features of coolants and lubricants for hobbing. (v) Diagnosis and correction of hobbing troubles.
Work held: on index centres	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 11: CAM MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Milling a uniform rise cam.</p> <p>Work held: on an index head</p>	<p>(a) Methods of mounting work as B6, U2, O4. (b) Design and features of cams. (c) Reasons for milling cams in universal milling machine. (d) Methods used to select setup. (e) Types of cutters used to mill cams. (f) Preparation of work for milling. (g) Methods of calculating radial movement of cam. (h) Calculation of table lead. (i) Methods of setting up change gears for index head mechanism. (j) Speed and feed for milling cams. (k) Application of coolant. (l) Amount of material removable in one pass. (m) Length of end mill in relation to diameter. (n) Method of setting work for depth of cut. (o) Methods of finishing cam. (p) Terms used in cam milling. (q) Use of reference lines to indicate beginning of cut. (r) Chip disposal and control.</p>
<p>2. Milling a double uniform rise and dwell cam.</p> <p>Work held: on an index head</p>	<p>(a) Method of mounting work as B6, U2, O4. (b) Design and features of double rise cams. (c) Calculations of angle of inclination of index head. (d) Calculation of change of gears for index head. (e) Methods of selecting milling cutter. (f) Cutting speeds and feeds. (g) Milling procedures. (h) Methods of aligning work with cutter. (i) Method of milling location of first cam. (j) Method of milling location of second cam. (k) Method of finishing cam.</p>
<p>3. Milling a simple face-cam.</p> <p>Work held: on an index head</p>	<p>(a) Methods of mounting work as B6, U2, O4. (b) Design and features of face cams. (c) Methods of laying out face cams. (d) Methods used in milling to layout. (e) Methods of roughing out. (f) Methods of finishing cuts. (g) Milling procedures.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 11: CAM MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (h) Methods of checking and testing. (i) Cutting speeds and feeds. (j) Methods of applying coolants. (k) Chip control and disposal.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 12: HELICAL AND SPIRAL MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Milling a helical groove on a cylinder. Work held: on index centres	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Design and features of helical surfaces. (c) Work requiring helical grooves. (d) Features and functions of helical milling attachments. (e) Methods of applying power to dividing or index centres. (f) Methods of centring cutter over blank. (g) Methods of setting table for correct helix angle. (h) Types and features of cutters used in milling helical grooves. (i) Calculations for feed gears for driving index centre. (j) Standard leads available. (k) Terms used in helical milling. (l) Methods of determining hand of helix. (m) Methods of supporting long work e.g. Jacks, etc. (n) Methods of cutting either right or left hand helices. (o) Methods of calculating angle to set table. (p) Feeds used when milling helices. (q) Cutting speed for milling and helix. (r) Methods of calculating correct indexing procedure. (s) Methods of applying cutting lubricants. (t) Chip control and disposal. (u) Methods of indexing blank for required number of divisions. (v) Tools and instruments used in checking and testing helical grooves.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 12: HELICAL AND SPIRAL MILLING
TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (w) Types and features of templates for testing groove shapes. (x) Precautions re backlash in feed mechanism when returning to start of cut. (y) Design and features of standard fluting cutters. (z) Reasons for using either down or up milling. (aa) Methods of calculating setover when milling helical cutters.
2. Milling a spiral on a conical surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O4. (b) Types and features of work requiring spiral grooves. (c) Types and features of end milling cutters. (d) Methods of setting up work for milling on taper. (e) Methods of locating cutter over blank. (f) Types and features of end milling attachments. (g) Methods of supporting long work. (h) Chip control and disposal. (i) Selection of cutter for type of groove required. (j) Methods of setting up for either right or left hand spirals. (k) Milling procedure. (l) Methods of allowing for backlash in feed train. (m) Leads available in standard gear trains. (n) Methods of determining angle of table swivel. (o) Methods of obtaining rake angle, when milling cutter blanks, by setover. (p) Methods of checking and testing tapered spirals.
Work held: on index centres	
3. Milling a worm.	<ul style="list-style-type: none"> (a) Method of mounting work as B6, U2, O4. (b) Types and features of worm threads. (c) Methods of mounting cutter on universal spiral milling attachment. (d) Types and features of thread milling cutters. (e) Methods of setting cutter to helix angle of worm thread.
Work held: on index centres	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 12: HELICAL AND SPIRAL MILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (f) Methods of locating cutter on work. (g) Calculation of change gears for correct lead. (h) Cutting speed for milling worm threads. (i) Amount of material left for finishing. (j) Feed rate for milling worm threads. (k) Methods of finishing thread.

BLOCK V: MILLING MACHINE PRACTICE

UNIT 13: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Drilling and boring. Work held: in a vise on the table on index head on rotary table	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O2, 3, 4, 5. (b) Reasons for drilling and boring in the milling machine. (c) Methods of preparing work for drilling. (d) Methods of layout. (e) Preparation of surfaces for layout. (f) Types, features and functions of layout tools. (g) Types and features of attachments used in drilling and boring operations. (h) Methods of mounting and driving attachments. (i) Types and features of precision measuring equipment. (j) Types and uses of toolmakers' buttons. (k) Methods of checking and testing location of holes. (l) Types and features of boring heads. (m) Accuracy obtainable using milling machine as jig borer. (n) Preparation of work for boring. (o) Speeds and feeds for drilling and boring. (p) Methods of feeding drills into work. (q) Types and features of drill adapters for the milling machine. (r) Drilling procedures. (s) Types and uses of cutting lubricants. (t) Methods of recentring holes started off centre. (u) Methods of chip control and disposal. (v) Methods of controlling depth of cut.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 13: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (w) Methods of mounting and removing tools and adapters on milling machine. (x) Diagnosis and correction of drill troubles. (y) Methods of measuring and gauging holes. (z) Precautions re springing work. (aa) Production methods. (ab) Methods of starting drills. (ac) Design and features of boring bars, boring heads, etc. (ad) Boring procedures. (ae) Methods of keeping bore parallel. (af) Relation of bar size to bore. (ag) Methods of avoiding chatter when boring. (ah) Precautions re care of machine and accessories.
2. Line boring.	<ul style="list-style-type: none"> (a) Methods of mounting work as B6, U2, O3, 7. (b) Reasons for line boring in the milling machine. (c) Types and features of boring bars used for line boring. (d) Methods of mounting tools in boring bars. (e) Methods of preparing work for boring. (f) Methods of measuring bores. (g) Boring procedures. (h) Types and features of measuring instruments for bores. (i) Surface finish obtainable. (j) Methods of preventing spring in boring bars. (k) Methods of supporting outer ends of boring bars. (l) Relation of bar size to bore. (m) Methods of finishing bores. (n) Types and uses of offset boring heads. (o) Methods of adjusting boring tools. (p) Methods of measuring tool adjustment. (q) Safety practices re hazard presented by rotating fly cutter.
Work held: on the table on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK V: MILLING MACHINE PRACTICE

UNIT 13: MISCELLANEOUS TECHNIQUES

OPERATIONS

KNOWLEDGE

3. Internal grooving.

Work held:

in a vise
on the table
on index head
on a fixture

- (a) Methods of mounting work as B6, U2, O2, 3, 4, 7.
- (b) Reasons for internal grooving.
- (c) Types, features and functions of internal grooves e.g. oil grooves, retaining clips, etc.
- (d) Types, features and functions of tools for internal grooving.
- (e) Types and features of helical grooves.
- (f) Methods of feeding work to produce helix.
- (g) Methods of feeding tool when cut is blind.
- (h) Chip control and disposal.
- (i) Methods of applying coolants and lubricants.
- (j) Methods used to obtain rapid feeds on milling machine.
- (k) Operating precautions re tool breakage.
- (l) Methods of checking and testing internal grooves.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI - PLANER PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	193
Unit 2. Work Holding Techniques.....	195
Unit 3. Horizontal Flat Surfacing Techniques..	197
Unit 4. Vertical Flat Surfacing Techniques....	200
Unit 5. Angular Flat Surfacing Techniques.....	203
Unit 6. Grooving Techniques.....	205
Unit 7. Forming Techniques.....	208
Unit 8. Contouring Techniques.....	210
Unit 9. Undercutting Techniques.....	211

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNTIL I: THE MACHINE

OPERATIONS

KNOWLEDGE

1. Oiling the machine

- (a) Names and functions of machine parts.
- (b) Kinds, uses and selection of lubricants.
- (c) Care and storage of lubricants.
- (d) Equipment for application of lubricants e.g. oil cans, grease guns, etc.
- (e) Statistical control of lubrication e.g. schedule charts, etc.
- (f) Types and features of lubricating equipment.
- (g) Precaution re over-lubricating motors, etc.
- (h) Safety practices re removing oil from floor.
- (i) Types and features of lubricating equipment e.g. pressure, drip feed, etc.
- (j) Maintenance of automatic lubricating equipment.
- (k) Safety practices re power off while lubricating the machine.
- (l) Recognition of unduly worn parts.
- (m) Location of lubricating stations, e.g. oil "wells" located in ways, etc.

2. Controlling the machine

- (a) Types, features and functions of primary controls, e.g. power, clutches, etc.
- (b) Features and functions of feed controls.
- (c) Precaution re reading manual and instruction cards.
- (d) Precaution re adjusting table stops before starting.
- (e) Operating procedures.
- (f) Safety practice re head, hands and loose clothing.
- (g) Precaution re clearance of tool heads from projections on table.
- (h) Use of inching switches.
- (i) Maximum table stroke.
- (j) Immediate diagnosis and correction of faulty operation.
- (k) Calculation of cutting speeds.
- (l) Adjustment of stroke.
- (m) Methods of raising the cross rail.
- (n) Precaution re-releasing locks on cross rail before raising.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNTIL I: THE MACHINE

OPERATIONS	KNOWLEDGE
3. Cleaning procedures	<ul style="list-style-type: none"> (a) Types and features of cleaning solvents and materials. (b) Types and uses of special equipment for cleaning large machines. (c) Methods of cleaning sliding bearing surfaces. (d) Precaution re use of air hose. (e) Methods of cleaning oil reservoirs. (f) Methods of cleaning T-slots. (g) Precaution re use of caustic cleaners. (h) Safety practices re locking the switch.
4. Adjusting the machine	<ul style="list-style-type: none"> (a) Methods of adjusting moving parts e.g. cross rail, tool heads, etc. (b) Methods of compensating for wear. (c) Recognition and diagnosis of excess wear. (d) Types and adjustment of clutches. (e) Responsibilities of the operator e.g. clean, lubricate, adjust, etc. (f) Correct belt tensions. (g) Fundamentals of moving parts. (h) Design and adjustment of gibs. (i) Recognition of maximum wear and need of overhaul. (j) Design and functions of all planer parts.
5. Handling and mounting the following accessories: vises jigs and fixtures angle plates V-blocks, etc.	<ul style="list-style-type: none"> (a) Types, features and function of standard accessories. (b) Handling and mounting of the accessories. (c) Types and features of lifting equipment. (d) Use of paper under fixtures e.g. for slippage. (e) Methods of removing "nicks" and "burrs" from table. (f) Precaution re cleanliness of mating parts. (g) Methods of checking and testing mounted accessories for truth. (h) Techniques for handling heavy equipment. (i) Care and storage of accessories. (j) Care of machine and accessories when mounting. (k) Diagnosis and correction of clamping and mounting troubles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding	<ul style="list-style-type: none"> (a) Types and features of holding equipment for various types of work e.g. angle plates, V-blocks, etc. (b) Accuracy required. (c) Shape of work pieces. (d) Quantity of parts to be machined. (e) Advantages and use of each set up. (f) Theory of work holding techniques.
2. Setting up work on the table	<ul style="list-style-type: none"> (a) Protection of the table from rough surfaces e.g. cardboard, etc. (b) Methods of "snagging" large castings. (c) Types, features and functions of standard clamping devices e.g. plain, V, finger, etc. (d) Types and functions of work stops e.g. pins, bars, etc. (e) Principles of using clamps e.g. shimming or "bolstering" weak sections. (f) Types, features and functions of braces for high castings. (g) Use of jacks and/or packing for long thin sections. (h) Features and functions of "poppets". (i) Types and features of T-slots. (j) Reasons for setting up work on the table. (k) Types, features and functions of packing and step blocks. (l) Types, features and care of parallels. (m) Care and storage of table mounting accessories. (n) Methods of "inching" and shifting heavy work on the table with crow bars, etc. (o) Location of clamps on work.
3. Setting up work on an angle plate	<ul style="list-style-type: none"> (a) Types, features and design of angle plates. (b) Techniques for mounting angle plates on the table. (c) Accessories used with the angle plate e.g. jacks, bolts, clamps, etc. (d) Methods of cleaning and preparing surfaces. (e) Methods of checking and truing surface plates. (f) Care and storage of angle plates. (g) Precaution re distortion when using clamps, parallels, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANNER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (h) Use of precision tools e.g. gauge blocks, sine bars, etc. (i) Use of stops, strips, etc. (j) Type of work requiring angle plate mounting. (k) Selection of the proper angle plate for the job.
4. Setting up work in a vise	<ul style="list-style-type: none"> (a) Types, features and limitations of vises e.g. sine, swivel, etc. (b) Techniques for mounting vises on the table. (c) Care and storage of vises. (d) Types and features of vise jaws e.g. plain, stepped, etc. (e) Methods of checking and truing vise jaws. (f) Accessories for mounting irregular work in a vise e.g. equalizing bars, bedding pieces, etc. (g) Methods of protecting finished work in the vise e.g. copper jaws, etc. (h) Techniques for holding irregular work e.g. packing, etc. (i) Preparation of rough castings for mounting e.g. snagging, etc. (j) Accuracy obtainable with a vise. (k) Types and features of hammers used for "bedding" work. (l) Precaution re rapping too hard when "bedding" down work. (m) Methods of holding cylindrical work e.g. V-blocks, etc. (n) Tension required for "bedding" and cutting work. (o) Diagnosis and correction of vise holding troubles. (p) Use of "hold downs" e.g. toe dogs, hack saw blades, etc. (q) Precaution re removing chips and burrs from work and vise. (r) Methods of setting up to layouts.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Setting up work in fixtures, such as:</p> <ul style="list-style-type: none"> indexing centre mountings V-blocks rotary tables jigs and fixtures parallels 	<ul style="list-style-type: none"> (a) Types, features and functions of common fixtures. (b) Techniques for mounting fixtures. (c) Factors governing fixture selection e.g. quantity, shape, etc. (d) Care and storage of fixtures. (e) Production methods. (f) Principles of indexing. (g) Tension required for centre mounted work. (h) Methods of truing and testing fixtures. (i) Location of fixtures on table. (j) Scope of work machined on fixtures. (k) Reasons for selecting and mounting work in fixtures.

BLOCK VI: PLANER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Shaping horizontal, external flat surface</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Planer tool design for roughing and finishing various materials. (c) Planing procedures e.g. for close and distant spaced surfaces. (d) Precaution re clearance of tool heads when first starting. (e) Techniques for using multiple tool heads. (f) Adjustment of clapper boxes. (g) Surface finish obtainable in the planer. (h) Types and features of tool holders. (i) Methods of mounting tools and tool holders. (j) Calculation of machining time. (k) Maximum cut allowable for various work. (l) Feeds and speeds for various materials. (m) Adjustment of length of stroke. (n) Advantages of electronic clapper boxes. (o) Chip control and disposal. (p) Diagnosis and correction of planing troubles, e.g. chatter, irregular surfaces, etc. (q) Reasons for bevelling edges on cast iron work. (r) Principles of planing to a layout.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (s) Speeds and feeds for rough and finish cuts. (t) Methods of setting tool down to work. (u) Principles of dial reading. (v) Precaution re checking clamps, etc., before starting cut. (w) Application of cutting oils. (x) Safety practices re head, hands and loose clothing. (y) Diagnosis and correction of warped work e.g. internal stresses, clamp position, etc. (z) Cutting oils for various materials. (aa) Diagnosis and correction of troubles from intermittent cuts e.g. tool head dropping, tool slippage, etc. (ab) Production methods. (ac) Recognition of worn cutting tools. (ad) Tool life expectancy. (ae) Calculation of cutting speeds. (af) Planing nomenclature. (ag) Precaution re interrupted cuts. (ah) Methods of removing burrs. (ai) Handling and protection of finished work. (aj) Principles of spring tools. (ak) Allowances for finishing cuts. (al) Application of coolants. (am) Working tolerance for the machine. (an) Methods of testing and adjusting the cross rail. (ao) Methods of testing and measuring surface finish. (ap) Types, features and functions of "outboard" supports and rolls. (aq) Precaution re having outboard supports and rolls "stable". (ar) Methods of re-aligning work and picking up cuts on long work.
2. Planing a horizontal, internal flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types and features of tool holders for internal work. (c) Tool design for internal work. (d) Visual aids for inspection of internal work e.g. mirrors, lights, etc. (e) Diagnosis and correction of machining troubles e.g. chatter, etc.
Work held:	
on the table	
on an angle plate	
in a vise	
on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (f) Chip disposal and handling. (g) Application of lubricants and coolants. (h) Dial reading. (i) Techniques for inspection and measuring internal surfaces. (j) Quality of finish obtainable. (k) Precaution re feeds in confined surfaces. (l) Methods of machining to a shoulder. (m) Techniques for working to a layout. (n) Depth of cut for roughing and finishing. (o) Care of planer and equipment when working blind. (p) Dial reading. (q) Calculations for dial reading. (r) Use of chalk mark on the dial for quick readings. (s) Allowances for tool "dig in" when dial reading. (t) Diagnosis and correction of dial reading errors e.g. dial slippage, loose gibs, worn feed screw, etc. (u) Use of dial indicators for precision tool depth settings.
3. Planing a horizontal, external recessed, flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Uses for recessed, flat surfaces. (c) Tool design for recessed surfaces. (d) Methods of giving tool clearance at each end of stroke. (e) Methods of measuring and inspecting recessed surfaces. (f) Techniques for working to a close tolerance. (g) Surface finish obtainable. (h) Chip control and disposal. (i) Calculation of depth re dial reading. (j) Methods of planing to a shoulder. (k) Procedures for machining a recessed surface. (l) Precaution re "chip build up" at the end of the stroke.
Work held: on the table on an angle plate in a vise on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 3: HORIZONTAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Planing a horizontal, undercut flat surface,</p> <p>Work held:</p> <p>on the table</p> <p>on an angle plate</p> <p>in a vise</p> <p>on a fixture</p>	<p>(a) Methods of mounting work as B7, U2, O2, 3, 4, 5.</p> <p>(b) Types of tool holders adaptable to undercut work.</p> <p>(c) Tool design for undercut work.</p> <p>(d) Advantages and disadvantages of solid tools.</p> <p>(e) Methods of checking and testing undercuts.</p> <p>(f) Methods of handling clapper box e.g. locking or lifting at end of stroke.</p> <p>(g) Features and functions of auxiliary clapper boxes.</p> <p>(h) Surface finish obtainable.</p> <p>(i) Application of lubricants and coolants.</p> <p>(j) Precaution re "locked" clapper box slippage.</p> <p>(k) Diagnosis and correction of undercutting troubles.</p> <p>(l) Corner design e.g. fillets, undercut, square, etc.</p> <p>(m) Length of stroke necessary for lifting tool.</p> <p>(n) Methods of measuring and inspecting undercut surfaces.</p> <p>(o) Surface finish required.</p> <p>(p) Calculation of planing time.</p>

BLOCK VI: PLANER PRACTICE

UNIT 4: VERTICAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Planing a vertical, external, flat surface.</p> <p>Work held:</p> <p>on the table</p> <p>on an angle plate</p> <p>in a vise</p> <p>on a fixture</p>	<p>(a) Methods of mounting work as B7, U2, O2, 3, 4, 5.</p> <p>(b) Principles of the clapper box.</p> <p>(c) Tool design for vertical facing.</p> <p>(d) Procedures in planing to a shoulder.</p> <p>(e) Techniques in setting straight and offset tool holders.</p> <p>(f) Inspection and measuring vertical faces.</p> <p>(g) Types and application of cutting compounds.</p> <p>(h) Calculation of cutting time.</p> <p>(i) Methods of measuring and inspecting surface finish.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 4: VERTICAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (j) Precaution re clearance for crosshead on deep work. (k) Production methods. (l) Techniques for using two tools at one time. (m) Precaution re tool "overhand" (Physics-resonance) (n) Planing nomenclature. (o) Diagnosis and correction of vertical planing troubles. (p) Methods of measuring length. (q) Types and uses of measuring instruments. (r) Safety practices re loose clothing, head, etc. (s) Methods of feeding the tool e.g. by hand, feed, etc. (t) Safety practices re flying chips e.g. face shields, chip shields, etc. (u) Methods of checking and testing the cross rail for truth. (v) Tools and equipment for testing the cross rail for truth. (w) Tolerance allowable for planer work. (x) Methods of checking and testing the planer head for "zero" setting. (y) Maximum cut for various materials. (z) Allowances for finishing. (aa) Maximum depth of cut. (ab) Methods of moving lever to a dial setting, e.g. bumping crank with hand, etc. (ac) Methods of picking up a cut, e.g. when readjusting the tool, sharpening, etc. (ad) Techniques for using multiple heads.
2. Planing a vertical, internal, flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types of work requiring internal vertical faced work. (c) Visual aids for internal work e.g. mirrors, lights, etc. (d) Methods of applying coolants. (e) Tool design. (f) Methods of "picking up" a cut. (g) Methods of measuring and inspecting internal work. (h) Chip control and disposal.
Work held: on the table on an angle plate in a vise on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 4: VERTICAL FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (i) Precaution re interrupted cuts. (j) Safety practices (need for safety zone). (k) Speeds and feeds for various materials. (l) Specifications e.g. accuracy for set up. (m) Diagnosis and correction of warping and distortion e.g. backing, clamping, etc. (n) Methods of preventing and eliminating chatter. (o) Methods of controlling depth of cut. (p) Layout procedures. (q) Safety practices re handling work e.g. burrs, etc. (r) Methods of machining to a shoulder. (s) Production methods.
3. Planing a vertical, external recessed, flat surface.	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Tool design for recessed work. (c) Means of relieving the chip at the end of the stroke e.g. chiseling, grooves, etc. (d) Types, features and uses of fillets and undercuts. (e) Precaution re back of recess holding up tool at back end of the stroke. (f) Problems with deep recessed surfaces e.g. tool overhang, etc. (g) Precaution re chip "build up" at the end of the stroke. (h) Uses for vertical recessed surfaces. (i) Surface finish obtainable. (j) Application of lubricants and coolants. (k) Surface finish required. (l) Methods of testing and measuring surface finish.
Work held: on the table on an angle plate in a vise on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 5: ANGULAR FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Planing an external, angular, flat surface.	(a) Methods of mounting work as B7, U2, O2, 3, 4, 5.
Work held:	(b) Methods of checking and testing cross-rails for "truth".
on the table	(c) Equipment used in checking and testing cross rails for truth e.g. inside micrometers, dial indicators, etc.
on an angle plate	(d) Types, features and uses of angular work.
in a vise	(e) Accessories used for planing angular work e.g. sine bars, sine vises, etc.
on a fixture	(f) Methods of truing work to a layout.
	(g) Materials suitable for shimming work.
	(h) Graduation reading e.g. on the swivel block.
	(i) Calculations of angles.
	(j) Production methods.
	(k) Tool design for roughing and finishing various materials.
	(l) Methods of checking and testing angular work.
	(m) Tools and equipment used for checking and testing angular work.
	(n) Diagnosis and correction of machining errors e.g. loose gibs, clapper box setting, etc.
	(o) Procedures for shaping V-grooves.
	(p) Principles of the vernier protractor.
	(q) Methods of handling large work e.g. protection of finished surfaces.
	(r) Methods of removing burrs.
	(s) Application of coolants and lubricants.
	(t) Procedures in "roughing" angular work.
	(u) Use of combined feeds for angular work.
	(v) Tolerance capacity for planed work.
	(w) Principles in working to a layout.
	(x) Tolerance allowable.
	(y) Surface finish obtainable.
	(z) Surface finish required.
	(aa) Methods of roughing and finishing angular work.
	(ab) Tolerance required.
	(ac) Methods of working to a layout.
	(ad) "Peculiarities" of the machine.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 5: ANGULAR FLAT SURFACING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Planing an internal, angular, flat surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types of internal angular work machined on a planer. (c) Methods of making starting holes for internal work e.g. burning, drilling, coring, etc. (d) Precaution re stroke setting e.g. clearance from planer head. (e) Uses for internal angular work. (f) Chip control and disposal. (g) Maximum cut e.g. spring of bar, chatter, etc. (h) Methods of checking and testing internal surfaces. (i) Quality of finish obtainable. (j) Precaution re feed in a confined area. (k) Application of cutting oils. (l) Calculation of angles. (m) Types and features of auxiliary clapper boxes. (n) Tool design for various materials.
<p>3. Planing an external, undercut, angular, flat surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Tool design. (c) Types of tools used e.g. solid, tool bits, etc. (d) Methods of measuring and inspecting undercut angles. (e) Calculations for measuring and inspecting. (f) Measuring and testing equipment for undercut surfaces. (g) Tolerance and surface finish necessary for various jobs. (h) Standards for dovetails. (i) Work procedure. (j) Methods of measuring and testing surface finish on undercut surfaces. (k) Measuring and testing equipment for undercut surfaces. (l) Methods of measuring and testing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Planing a plain groove in an external, horizontal surface.	(a) Methods of holding work as B7, U2, O2, 3, 4, 5.
Work held: on the table on an angle plate in a vise on a fixture	(b) Types and uses of grooves e.g. keyways, etc. (c) Tool design for grooving. (d) Work procedures for grooving. (e) Methods of centring the tool. (f) Layout techniques. (g) Testing and measuring tools and equipment. (h) Keyway standards. (i) Techniques for checking and testing work for alignment. (j) Methods of measuring depth. (k) Types, features and functions of measuring tools. (l) Features and functions of key gauges. (m) Methods of relieving ends of blind grooves e.g. feather keyways. (n) Chip control and disposal in blind grooves. (o) Diagnosis and correction of grooving troubles e.g. chatter, tool breakage, etc. (p) Types and uses of multiple tool holders. (q) Methods of setting and adjusting tools in multiple tool holders. (r) Precaution re clapper box setting. (s) Speeds and feeds for grooving various materials. (t) Surface finish obtainable. (u) Calculating time for grooving. (v) Selection of cutting oils. (w) Surface finish obtainable. (x) Sizing techniques. (y) Safety practices with tools, fingers, etc. (z) Surface finish required. (aa) Methods of controlling overhang with long work e.g. rolls, slides, etc. (ab) Precaution re alignment of rolls or slides. (ac) Safety practices re placing rags on the end of over hanging work. (ad) Methods of re-aligning long work. (ae) Maximum width of grooving tools for various machines. (af) Production methods.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Planing a plain groove in an internal, horizontal surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Methods of mounting tools. (c) Principles of tool setting e.g. amount of overhang, etc. (d) Uses for internal grooves. (e) Keyway standards for plain work. (f) Standards for keyway tapers. (g) Methods of obtaining tapers. (h) Types of hard faced tools e.g. stellite, carbide, etc. (i) Precaution re tool "digging in" at ends of stroke. (j) Surface finish obtainable. (k) Methods of measuring and inspecting internal grooves. (l) Chip control and disposal for internal work. (m) Methods of relieving the ends of a groove for internal work. (n) Diagnosis and correction of internal grooving troubles. (o) Roughing and finishing procedures.
<p>3. Planing a plain groove in an external, vertical surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types of tools and tool holders suitable for grooving on vertical faces. (c) Selection of locked or loose clapper boxes. (d) Production methods. (e) Principles of planing to a layout. (f) Calculations for setting tool from table. (g) Methods of "locating" vertical height of tool. (h) Dial reading.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Planing a plain groove in an internal, vertical surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types and features of tool holders for vertical, internal faces. (c) Methods of positioning the tool. (d) Visual aids e.g. lighting, mirrors, etc. (e) Layout techniques for internal work. (f) Procedures for internal grooving.
<p>5. Planing a plain groove in an external, angular surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on a table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Types and uses for grooved angular work. (c) Methods of squaring tools from angular surfaces. (d) Methods of testing and inspecting. (e) Equipment used for truing to faces for grooving e.g. dial indicators, feeler gauges, etc. (f) Care, handling and storage of truing equipment. (g) Improvised measuring equipment for grooves, e.g. keystone, etc.
<p>6. Planing a plain groove in an internal, angular surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Selection of speeds and feeds e.g. by charts, calculation, performance, etc. (c) Specifications e.g. accuracy required. (d) Features and functions of auxiliary clapper boxes. (e) Preparation of castings e.g. chipping, sand blasting, etc. (f) Characteristics of various materials.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 6: GROOVING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>7. Planing a plain groove in an undercut surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Methods of mounting tools for undercut surfaces. (c) Application of lubricants. (d) Methods of centring tool. (e) Methods of measuring and inspecting obstructed grooves. (f) Clapper box setting e.g. locked, loose, etc. (g) Make shift measuring equipment in shop e.g. key stock, etc. (h) Types and uses of ball gauges and small hole gauges.

BLOCK VI: PLANER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Planing an external curved surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Tool design for formed surfaces. (c) Methods of grinding forming tools e.g. off-hand, tool grinder, etc. (d) Methods of testing and checking forming tools e.g. templates, etc. (e) Preparation of work for forming. (f) Techniques for forging solid forming tools. (g) Principles of hardening and tempering. (h) Applications of coolants and lubricants for external work. (i) Maximum width possible to be formed at one time e.g. condition of machine, etc. (j) Surface finish obtainable. (k) Selection of cutting speeds and feeds for forming. (l) Methods of measuring and inspecting formed surfaces e.g. templates, mechanics blue, etc. (m) Production methods. (n) Uses for formed surfaces. (o) Methods used for setting forming tools.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<p>(p) Care and storage of templates.</p> <p>(q) Diagnosis and correction of forming troubles.</p> <p>(r) Principles of spring tools.</p> <p>(s) Method of using combined automatic and hand feeds for roughing cuts.</p> <p>(t) Care, protection and handling of finished work.</p> <p>(u) Care and storage of forming tools.</p> <p>(v) Methods of "locating" the forming tool.</p> <p>(w) Reasons for using multiple forming tools.</p> <p>(x) Types and features of tool slide stops.</p> <p>(y) Calculations for dial reading.</p> <p>(z) Uses of chalk for rapid dial reading.</p> <p>(aa) Tolerances allowable.</p> <p>(ab) Methods of working to a layout.</p> <p>(ac) Precaution re interrupted cuts.</p>
2. Planing an internal curved surface	<p>(a) Methods of mounting work as B7, U2, O2, 3, 4, 5.</p> <p>(b) Methods of mounting internal forming tools.</p> <p>(c) Uses for internal curved surfaces.</p> <p>(d) Safety practices re head and hands on internal work.</p> <p>(e) Methods of measuring and inspecting curved surfaces.</p> <p>(f) Care when handling and storing inspection equipment.</p> <p>(g) Cutting speeds and feeds for internal work.</p> <p>(h) Coolants and lubricants for various materials.</p> <p>(i) Application of coolants and lubricants to internal work.</p> <p>(j) Techniques for preventing chatter on large radii and fillets.</p> <p>(k) Procedures for roughing and finishing internal work.</p> <p>(l) Reasons for not using tracers, etc.</p>
Work held: on the table on an angle plate in a vise on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 7: FORMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Planing an external, irregular surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Reasons for selecting single or multiple tools for forming. (c) Uses for irregular surfaced work. (d) Precaution re backlash on small curves, when roughing. (e) Procedures for roughing irregular forms. (f) Methods of measuring and inspecting irregular forms. (g) Methods of measuring surface finish.

BLOCK VI: PLANER PRACTICE

UNIT 8: CONTOURING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Planing a contour on an external surface.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on an angle plate in a vise on a fixture 	<ul style="list-style-type: none"> (a) Methods of holding work as B7, U2, O2, 3, 4, 5. (b) Uses for external contoured surfaces. (c) Types and features of radius arms for contoured surfaces. (d) Types and features of hydraulic tracing equipment. (e) Methods of mounting radius arms and tracing equipment. (f) Care and storage of templates. (g) Methods of contouring with a template and dial indicator. (h) Techniques for roughing out work. (i) Tool design for contouring work. (j) Methods of measuring and testing external contoured surfaces e.g. templates, shadow-graphs, etc. (k) Care and storage of testing and measuring equipment. (l) Calculation for cutting speeds and feeds. (m) Diagnosis and correction of contouring troubles. (n) Preparation of work e.g. chipping castings, snagging, etc. (o) Coolants and lubricants used for various materials.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 8: CONTOURING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<p>(p) Methods of picking up cut.</p> <p>(q) Allowances for finishing cuts.</p> <p>(r) Maximum cut obtainable.</p> <p>(s) Clapper box setting for contoured work.</p> <p>(t) Tolerance allowable.</p> <p>(u) Types and features of tool post mounted contouring equipment e.g. worm and worm wheel.</p> <p>(v) Care, handling and protection of surface finish.</p> <p>(w) Precaution re mounting work square and on clean surfaces.</p>

BLOCK VI: PLANER PRACTICE

UNIT 9: UNDERCUTTING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Planing a T-slot.	<p>(a) Methods of mounting work as B7, U2, O2, 3, 4, 5.</p>
Work held:	<p>(b) Preparation of work for T-slotting e.g. procedures.</p>
on the table	<p>(c) Layout techniques</p>
on an angle plate	<p>(d) Uses for T-slots.</p>
in a vise	<p>(e) Tool design for roughing and finishing.</p>
on a fixture	<p>(f) Cutting speeds for various materials.</p> <p>(g) Methods of locking the clapper box e.g. taper pins, set screws, etc.</p> <p>(h) Procedures for making a T-slot.</p> <p>(i) Roughing and finishing feeds.</p> <p>(j) Allowances for finishing cuts.</p> <p>(k) Techniques for working to a layout.</p> <p>(l) Diagnosis and correction of T-slotting troubles.</p> <p>(m) Coolants and lubricants for various materials.</p> <p>(n) Methods of measuring and inspecting T-slots.</p> <p>(o) Standards for T-slots, T-bolts and T-nuts.</p> <p>(p) Heat treatment for forged tools.</p> <p>(q) Tolerances for standard fits.</p> <p>(r) Cutting speeds and feeds.</p> <p>(s) Maximum cut.</p> <p>(t) Allowances for finishing cuts.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VI: PLANER PRACTICE

UNIT 9: UNDERCUTTING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	(u) Calculation for machining time. (v) Machining qualities of various materials.
2. Planing an angular undercut surface.	(a) Methods of mounting work as B7, U2, O2, 3, 4, 5. (b) Reasons for undercutting corners e.g. relieving.
Work held: on the table on a faceplate in a vise on a fixture	(c) Tool design for undercutting. (d) Precaution re clearance for tool holder. (e) Precaution re tool digging in. (f) Effect of undercuts e.g. weakening. (g) Dial reading for depth of cut.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII - HEAT TREATING PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Equipment.....	214
Unit 2. Hardening Techniques.....	214
Unit 3. Surface Hardening Techniques.....	217
Unit 4. Tempering Techniques.....	220
Unit 5. Annealing Techniques.....	221
Unit 6. Miscellaneous Techniques.....	223

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 1: THE EQUIPMENT

OPERATIONS	KNOWLEDGE
1. Controlling the equipment	<ul style="list-style-type: none"> (a) Types, features and functions of primary and secondary controls. (b) Operating precautions. (c) Safety practices.
2. Cleaning the equipment	<ul style="list-style-type: none"> (a) Types and uses of cleaners. (b) Cleaning techniques. (c) Safety practices.
3. Adjusting the equipment	<ul style="list-style-type: none"> (a) Methods of adjusting moving parts. (b) Methods of compensating for wear, burning and warping. (c) Types, features and functions of tools used.

BLOCK VII: HEAT TREATING PRACTICE

UNIT 2: HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Hardening carbon tool steel	<ul style="list-style-type: none"> (a) Types, features and characteristics of carbon tool steel. (b) Methods of heating the job e.g. furnace, torch, forge, etc. (c) Methods of cooling the job e.g. water, oil, brine, salts, etc. (d) The effect of heating and cooling on physical properties e.g. hardness, tensile strength, ductility, etc. (e) The effect of heating and cooling on grain size. (f) Reason for using various quenching baths. (g) Methods of maintaining the quenching baths. (h) Diagnosis and correction of hardening troubles. (i) The theory of hardening, use of the hardening curve. (j) Methods of testing before and after hardening. (k) Reasons for using carbon tool steel.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 2: HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (l) The effect of carbon content on hardening temperature, hardenability, etc. (m) The effect of various quenching media on hardness, brittleness, toughness, etc. (n) Preparation of work for hardening e.g. de-scaling, normalizing, etc. (o) Need for "soaking" job to obtain even heat. (p) Methods of measuring and controlling heat. (q) Methods of minimizing distortion when heating. (r) Methods of minimizing distortion when cooling. (s) Precautions when heating and cooling work having holes, thick and thin sections, etc. (t) Design of job to minimize cracking, strains, etc. (u) Precautions re over-heating, decarbonizing, coarse grain, etc. (v) Methods of manufacturing tool steel. (w) Carbon tool steel nomenclature. (x) Characteristics and heat treatments of various carbon tool steels, use of hand book. (y) Methods of lighting and using furnaces, torches, forges, etc. (z) Care, use and storage of optical and electrical temperature - measuring equipment. (aa) Care, use and storage of testing equipment. (ab) Safety precautions re use of salts, use of gas burning equipment, use of quenching baths, marking hot materials, tongs, etc., removal of fumes, etc. (ac) Recognition of hardening temperature e.g. colour non-magnetic, use of temperature measuring instruments, etc. (ad) Hardening procedures. (ae) Use of SAE and AISI number conversion tables. (af) Use of hardness conversion tables e.g. Vickers, Brinell, Scleroscope, Rockwell, etc. (ag) Choice of carbon steel for the job. (ah) Methods used in recognizing various steels. (ai) Methods used in the "letting down" or "one heat" method of hardening and tempering. (aj) Precautions re decarburized skin when testing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 2: HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	(ak) Precautions re "soaking" for prolonged periods, decarburization.
2. Hardening alloy steels	<ul style="list-style-type: none">(a) Types, features and characteristics of alloy steels.(b) The effect of heating and cooling alloy steels on physical properties.(c) Quenching media used for hardening alloy steels.(d) The theory of hardening alloy steels.(e) Methods of testing alloy steels.(f) Advantages of alloy steels over plain carbon steel.(g) The effect of various alloys on hardening characteristics.(h) The effect of various quenching media on alloy steels.(i) Preparation of work for hardening.(j) Choice of alloy steel for specific job, use of hand book.(k) Methods of manufacturing alloy steels.(l) Alloy steel nomenclature.(m) Recognition of hardening temperature.(n) Hardening procedures.(o) SAE and AISI number tables for alloy steels.(p) Methods of avoiding hardening failures.(q) Recognition of various alloys.
3. Hardening non-ferrous alloys	<ul style="list-style-type: none">(a) Types, features and characteristics of hardenable non-ferrous alloys.(b) The effect of heating and cooling of non-ferrous alloys.(c) Quenching media for hardening non-ferrous alloys.(d) The theory of hardening non-ferrous alloys.(e) Methods of testing.(f) Advantages of non-ferrous alloys.(g) The effect of various quenching media.(h) Preparation of work for hardening.(i) Choice of alloy specific job.(j) Methods of manufacturing.(k) Non-ferrous alloy nomenclature.(l) Hardening procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 2: HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (m) Methods of avoiding hardening failure. (n) Recognition of various non-ferrous alloys.

BLOCK VII: HEAT TREATING PRACTICE

UNIT 3: SURFACE HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Case hardening work	<ul style="list-style-type: none"> (a) Types, features and characteristics of steel suitable for case hardening. (b) The theory of case hardening. (c) Types of case hardening e.g. cyaniding, nitriding, carbonitriding, etc. (d) The scope of case hardening. (e) Methods of carburizing e.g. sprinkling with salts, immersion in molten salts, packing in carbonaceous materials, etc. (f) Depth of case obtained by various methods. (g) Physical structures obtained by various methods. (h) Types, features and characteristics of quenching media. (i) Methods of using and maintaining quenching baths. (j) Diagnosis and correction of case hardening troubles. (k) Methods of testing before and after hardening. (l) The effect of case hardening on various types of steels. (m) Preparation of work for case hardening. (n) Methods of heating work to be case hardened. (o) Methods of measuring and controlling heat. (p) Time required for carburizing work. (q) Methods of minimizing distortion. (r) Design of job to prevent case hardening failures. (s) Reasons for case hardening. (t) Care, use and storage of temperature measuring equipment. (u) Recognition of carburizing and hardening temperatures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 3: SURFACE HARDENING TECHNIQUES

OPERATIONS

KNOWLEDGE

1. Cont'd.

- (v) Methods of handling and quenching.
- (w) Factors governing choice of steel for work requiring case hardening.
- (x) Precautions re care, storage and use of poisonous case hardening compounds; elimination of poisonous fumes; mixing of cyanides and nitrites; marking hot tools and materials.
- (y) Care and storage of surface hardening compounds to prevent loss of strength.
- (z) Safety practices re use of goggles, gloves and suitable clothing, shoes, etc.
- (aa) Methods of heating work.
- (ab) Case hardening procedures for various methods.
- (ac) Precautions re decarburizing.
- (ad) Relationship between time, temperature and depth of "case".
- (ae) Methods of testing depth of "cases".

2. Pack hardening work

- (a) Types, features and functions of various carburizing compounds.
- (b) Methods of packing and sealing.
- (c) Methods of heating the "pack".
- (d) Types, features and use of furnaces suitable for pack hardening.
- (e) Methods of measuring, recording and controlling temperature of furnaces.
- (f) Reasons for pack hardening.
- (g) Depth of case obtainable.
- (h) Types of work requiring pack hardening.
- (i) Types of containers suitable for holding the "pack".
- (j) Time required for various case depths.
- (k) Types of steel suitable for pack hardening.
- (l) Methods of handling hot materials.
- (m) Methods of quenching.
- (n) Methods of "breaking open" the pack.
- (o) Methods of handling and unloading the pack.
- (p) Precautions re handling hot work, quenching, etc.
- (q) Safety practices re use of safety equipment, familiarity with Safety Code.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 3: SURFACE HARDENING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Induction hardening work	<ul style="list-style-type: none">(a) The scope of induction hardening.(b) Types, features and characteristics of steels suitable for induction hardening.(c) Types, features and functions of induction heating equipment.(d) Advantages and disadvantages of induction heating.(e) Time required for induction hardening.(f) Preparation of work for induction hardening.(g) Methods of quenching induction heated work.(h) Types of work requiring induction hardening.(i) Power, light and space requirements for induction equipment.(j) The theory of induction heating.(k) Induction hardening procedures.(l) Safety practices re use of high frequency equipment.
4. Flame hardening work	<ul style="list-style-type: none">(a) Types, features and functions of flame hardening equipment.(b) Care and storage of torches, tips, regulators, etc.(c) The scope of flame hardening.(d) Advantages and disadvantages of flame hardening.(e) The theory of flame hardening.(f) Flame hardening procedures.(g) Types of flames suitable for flame hardening.(h) Methods of regulating flame.(i) Methods of cooling work.(j) Methods of minimizing distortion.(k) Time required.(l) Temperatures required.(m) Types of work requiring flame hardening.(n) Types of steel suitable for flame hardening.(o) Safety precautions re use of torches, hoses, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 4: TEMPERING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Tempering carbon tool steel	<ul style="list-style-type: none"> (a) The effect of carbon content on tempering temperatures. (b) Reasons for tempering. (c) Tempering procedures. (d) Methods of heating work for tempering. (e) Methods of cooling after tempering. (f) Time required for tempering. (g) The effect of time and temperature on finished job. (h) The effect of "long-holding" at tempering temperatures. (i) Methods of recognizing tempering temperatures. (j) Types, features and use of tempering baths. (k) Types, features and functions of tempering furnaces. (l) Precautions re use of nitrites when tempering. (m) Method used for tempering using the "letting down" or "one heat" method of hardening and tempering. (n) Preparation of work for tempering. (o) Physical structures obtained from tempering at various temperatures. (p) Testing tempered work for hardness, brittleness, etc. (q) Types, features, use and care of physical testing equipment. (r) Types, features, use and care of temperature testing and control equipment. (s) The theory of tempering. (t) Diagnosis and correction of tempering troubles. (u) Reasons for tempering as soon as possible after hardening. (v) Knowledge of tempering temperatures required for various degrees of hardness. (w) Tempering temperatures required for specific needs, use of handbook. (x) Safety practices re use of heat treating tools and equipment. (y) The effect of over-heating.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 4: TEMPERING TECHNIQUES

OPERATIONS	KNOWLEDGE
2: Tempering alloy steels	<ul style="list-style-type: none"> (a) The effect of alloy content on tempering temperatures. (b) Tempering procedures. (c) Recognition of tempering temperatures. (d) Preparation of work. (e) The effect of tempering on alloy steels. (f) The theory of tempering alloy steels. (g) Physical structures obtained by tempering at various temperatures. (h) Specific temperatures required for the job, use of handbook. (i) Diagnosis and correction of tempering troubles. (j) The effect of over-heating. (k) Safety practices re use of hot materials, tools and equipment.

BLOCK VII: HEAT TREATING PRACTICE

UNIT 5: ANNEALING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Annealing ferrous metals, such as: <ul style="list-style-type: none"> low carbon steel medium carbon steel high carbon steel alloy steels cast iron, etc. 	<ul style="list-style-type: none"> (a) Types, features and characteristics of ferrous metals. (b) Methods of heating the job e.g. furnaces, torches, forges, etc. (c) Methods of cooling the job e.g. cooling, in furnace, cooling in insulating materials, etc. (d) The effect of heating and cooling on physical properties. (e) Reasons for annealing e.g. to soften, to improve grain structure, stress relieving, etc. (f) Types, features and characteristics of insulating materials suitable for annealing. (g) The theory of annealing. (h) Methods of testing before and after annealing. (i) The effect of carbon content on final softness, machineability, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 5: ANNEALING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (j) The effect of various alloys on annealing. (k) Temperatures required for annealing various steels. (l) Methods of controlling heating and cooling rates. (m) Methods of minimizing distortion. (n) Precautions re over-heating. (o) Use of handbook for annealing temperatures for various steels. (p) Recognition of annealing temperatures. (q) Time required for annealing. (r) Annealing procedures. (s) Safety precautions re use of gas burning equipment, removal of fumes, handling hot materials, use of safety equipment, etc. (t) Methods of "quick-annealing". (u) Reasons for "quick-annealing". (v) The effect of "quick-annealing" compared with conventional annealing. (w) Diagnosis and correction of annealing troubles. (x) The effect of work-hardening on annealed work.
2. Annealing non-ferrous metals, such as:	<ul style="list-style-type: none"> (a) Methods of annealing non-ferrous metals. (b) Reason for annealing non-ferrous metals. (c) Recognizing annealing temperatures. (d) Recognizing need for annealing. (e) Methods of cooling. (f) Rate of cooling. (g) Types and uses of quenching baths. (h) Methods of cleaning work before annealing. (i) Reasons for cleaning before annealing. (j) Methods of cleaning after annealing. (k) Methods of de-scaling. (l) Types, features and characteristics of pickle baths. (m) Precautions re use of acids when making, using and handling "pickles". (n) Safety practices re use of goggles and proper clothing when quenching in pickle baths (o) Types and features of handling equipment used when "pickling".
copper	
copper alloys	
aluminum	
aluminum alloys	
monel metal, etc.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 5: ANNEALING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	(p) Annealing procedures. (q) Testing non-ferrous metals for softness, ductility, malleability, etc.
3. Spot-annealing work, such as: castings rolled shapes forged shapes welded shapes, etc.	(a) The theory of spot-annealing. (b) Reasons for spot-annealing. (c) Methods of heating work to be spot-annealed e.g. torch, arc, high frequency equipment, etc. (d) Spot-annealing procedures. (e) Precautions when spot-annealing re distortion of work. (f) Safety practices re use of goggles and safety equipment. (g) Methods of controlling cooling rate. (h) Temperatures and time required for spot-annealing. (i) The effect of spot-annealing on physical properties. (j) Factors governing the choice of spot-annealing, deep-annealing or quick-annealing.

BLOCK VII: HEAT TREATING PRACTICE

UNIT 6: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Normalizing (quick annealing) work, such as: cast iron mild steel carbon tool steel alloy steel non-ferrous metals	(a) Types, features and characteristics of various metals. (b) Reasons for normalizing e.g. refinement of grain structure, stress relieving, softening, improving machinability, etc. (c) The theory of normalizing. (d) Time required for normalizing. (e) Factors governing the choice between normalizing or annealing. (f) Methods of heating and cooling work. (g) Temperatures required for normalizing, use of handbook.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 6: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (h) The effect of normalizing on physical properties. (i) Methods of testing before and after normalizing. (j) The effect of carbon and alloy content on softness, machinability, tensile strength, etc. (k) Methods of controlling heating and cooling rates. (l) Methods of minimizing distortion. (m) Normalizing procedures. (n) Recognition of normalizing temperatures. (o) Diagnosis and correction of normalizing troubles. (p) Safety practices when using hot materials, equipment, etc.
2. Stress relieving work, such as: castings forgings rolled shapes welded shapes, etc.	<ul style="list-style-type: none"> (a) The theory of stress relieving. (b) Reason for stress relieving. (c) The relationship of stress relieving to normalizing and annealing. (d) Temperatures required for stress relieving. (e) Time required for stress relieving. (f) Methods of heating and cooling work. (g) The effect of stress relieving on physical properties. (h) Stress relieving procedures. (i) Recognition of temperatures required. (j) Safety practices - hazard: hot materials, equipment, etc.
3. Spheroidizing work	<ul style="list-style-type: none"> (a) The theory of spheroidizing. (b) Reasons for spheroidizing. (c) Temperatures required for spheroidizing. (d) Time required. (e) Factors governing the decision to spheroidize work. (f) Spheroidizing procedures. (g) Types, features and use of furnaces and time-temperature equipment suitable for spheroidizing work. (h) The effect of spheroidizing on physical properties.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VII: HEAT TREATING PRACTICE

UNIT 6: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	(i) Method of examining and testing spheroidized work. (j) The effect of carbon content on spheroidized work. (k) Methods of minimizing distortion.
4. Artificial aging work	(a) The theory of artificial aging. (b) Time and temperatures required. (c) Reasons for artificial aging. (d) Physical effects of artificial aging. (e) Aging procedures.
5. Graphitizing cast iron or steel	(a) The theory of graphitizing. (b) Time and temperatures required. (c) Reasons for graphitizing. (d) The effect of graphitizing on physical properties. (e) Graphitizing procedures.
6. Malleablizing white cast iron	(a) The theory of malleablizing. (b) Time and temperatures required. (c) Reasons for malleablizing. (d) Physical effects produced. (e) Malleablizing procedures.
7. Postheating welded joints	(a) The theory of postheating. (b) Time and temperatures required. (c) Reasons for postheating. (d) Physical effects produced. (e) Postheating procedures. (f) Methods of heating.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII - GRINDING PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	227
Unit 2. Work Holding Techniques.....	229
Unit 3. Offhand Grinding Techniques.....	231
Unit 4. Surface Grinding Techniques.....	232
Unit 5. Cylindrical Grinding Techniques.....	234
Unit 6. Internal Grinding Techniques.....	237
Unit 7. Tool Grinding Techniques.....	240
Unit 8. Cutter Grinding Techniques.....	247
Unit 9. Cutoff Grinding Techniques.....	252
Unit 10. Miscellaneous Grinding Techniques.....	253

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	<ul style="list-style-type: none"> (a) Features and functions of parts of machine. (b) Method of selecting the correct lubricant. (c) Kinds and features of lubricants. (d) Lubrication procedures. (e) Types and features of lubrication equipment. (f) Frequency of lubrication. (g) Statistical control of lubrication e.g. charts, etc. (h) Methods of protecting lubrication points from grinding dust.
2. Controlling the machine	<ul style="list-style-type: none"> (a) Features and functions of control mechanisms. (b) Methods of using color to distinguish moving parts and control points. (c) Interpretation of the manufacturers' instructions and specifications from the operator's manual. (d) Safety practices - points to check before starting. (e) Methods of testing grinding wheel before using.
3. Cleaning the machine	<ul style="list-style-type: none"> (a) Methods of protecting the machine from abrasive particles. (b) Types and uses of solvents and cleaners. (c) Cleaning procedures. (d) Precautions re use of compressed air forcing particles under slides. (e) Safety practices - power off while cleaning machine.
4. Adjusting the machine	<ul style="list-style-type: none"> (a) Methods of adjusting moving parts. (b) Methods of compensating for wear. (c) Methods and procedures used in testing grinding equipment. (d) Methods used for testing spindle speed. (e) Types, features and functions of tools used in testing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
4. Cont'd	<ul style="list-style-type: none"> (f) Methods of checking and testing wheel spindle. (g) Causes of grinding errors. (h) Allowances for fits in moving parts e.g. spindle, table, etc. (i) Safety practices re power off while adjusting machine.
5. Handling and mounting abrasive wheels and belts	<ul style="list-style-type: none"> (a) Types, features and functions of abrasives. (b) Types, features and functions of grinding wheels and mounted points. (c) Methods used in truing grinding wheels. (d) Types, features and functions of grinding wheel bushings. (e) Methods of grading and testing grinding wheels. (f) Types, features and functions of grinding wheel bonds. (g) Standard grinding wheel markings. (h) Types, features and functions of standard wheel dressers. (i) Types, features and uses of Silicon Carbide wheels. (j) Types, features and uses of Aluminum oxide wheels. (k) Types, features and uses of Diamond Wheels. (l) Selecting correct grinding wheel. (m) Grinding wheel speeds. (n) Rate of stock removal. (o) Factors governing the selection of type of abrasive. (p) Factors governing the selection of grade. (q) Factors governing the selection of bond. (r) Safety practice and precaution: test wheel by "ring test" before mounting. (s) Safety practice - operator stand out of line of wheel rotation -- hazard: flying pieces. (t) Types, features and functions of wheel flanges and arbors. (u) Methods of cushioning wheel flanges against wheels. (v) Care and storage of wheels. (w) Methods of testing wheels. (x) The effect of wheel speed on cutting characteristics.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work	<ul style="list-style-type: none"> (a) Selecting the type of grinding machine and accessories. (b) The type of operation to be performed. (c) The accuracy required. (d) Weight size and shape of the work piece. (e) Number of parts to be made. (f) The capacity of the machine. (g) Various methods of holding work.
2. Setting up work in chucks, such as: 3-jaw universal 4-jaw independent magnetic (permanent) electro-magnetic collets	<ul style="list-style-type: none"> (a) Types, features, functions and limitations of chucks. (b) Chucking procedures e.g. clean chuck, etc. (c) Types of work that can be conveniently mounted in chucks. (d) Methods of truing chucks. (e) Methods of controlling magnetic chucks. (f) Chuck pressure required. (g) Operating precaution re work overhang. (h) Types and uses of de-magnetizing equipment (Physics-magnets). (i) Methods of mounting chucks, etc. on machine.
3. Setting up work: on centres on mandrels	<ul style="list-style-type: none"> (a) Preparation of work for mounting (b) Types, features and functions of grinding machine centers. (c) Types and features of center lubricants. (d) Methods of applying lubricant. (e) Methods of driving work on centers. (f) Methods of supporting long work. (g) Methods of testing centers for run out. (h) Types and features of live and dead head-stock centers. (i) Types and uses of indicating equipment. (j) Care and inspection of grinder centers. (k) Preparation of work for mounting on mandrels and centers. (l) Types and features of work rests. (m) Methods of heat dissipation (Physics-heat). (n) Precautions re adjustment of rest after each pass. (o) Methods of determining the number of rests required

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Setting up work: on the table on a fixture in a vise	(a) Types of work requiring table mounting. (b) Setup procedures. (c) Types and features of clamping devices. (d) Methods of "indicating" work. (e) Types, features and functions of dial indicators and accessories. (f) Mechanics of clamping - Physics. (g) Precautions re distorting work when clamping. (h) Methods of supporting overhanging sections of the work. (i) Types and features of fixtures suitable for table mountings. (j) Safety precautions re projections on work hitting wheel. (k) Types, features and functions of grinder vises. (l) Methods of protecting work in vises. (m) Types and features of soft jaws. (n) Methods of attaching vises to machine tables.
5. Holding work: by hand	(a) Types of work usually held by hand. (b) Grinding procedures. (c) Methods of cooling work. (d) Operating precautions re jamming wheel, jamming work between work rest and wheel, work rest close to wheel, use of safety equipment such as guards, shields, etc. (e) Safety practices loose clothing, worn gloves, holding work with rags, etc., use of face shields, goggles, etc. (f) Methods of grinding heavy work. (g) Methods of grinding small work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 3: OFFHAND GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Snagging a casting	(a) Types and features of work best done by offhand grinding methods.
Work held: free, by hand	(b) Methods of removing sprues, gates and risers from castings.
	(c) Types and features of wheels used in snagging operations.
	(d) Types and features of equipment used for portable grinding.
	(e) Types and features of swing frame grinders.
	(f) Types and features of floor stand grinders.
	(g) Methods of billet grinding.
	(h) Types of wheels mounted on floor grinders for snagging.
	(i) Types and features of guards used on floor grinders.
	(j) Methods of using portable grinders on welded work.
	(k) Grinding wheel safe speeds recommended for various operations.
	(l) Types, features and uses of organic bond wheels.
	(m) Wheel efficiency obtainable in snagging operations.
	(n) Grinding procedures.
	(o) Safety practices-adequate protection from flying particles (in case of wheel breakage).
	(p) Safety practices-use of face shields and goggles.
	(q) Methods of installing and servicing offhand grinding equipment.
	(r) Methods of controlling dust.
	(s) Methods of mounting grinding wheels on various machines.
	(t) Safety practices: testing wheels before mounting by ring test, etc.
	(u) Methods of dressing wheels.
	(v) Recognition of loaded or glazed wheels.
	(w) Precautions re setting fire with flying hot particles (sparks).

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 3: OFFHAND GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Sharpening a tool	(a) Types and features of work or tools sharpened by hand.
Work held: by hand	(b) Methods of grinding single point tools by hand.
	(c) Types and features of work rests used on bench or pedestal grinders.
	(d) Types and features of wheels recommended for bench grinders.
	(e) Care and maintenance of bench grinders.
	(f) Methods of truing and dressing bench grinder wheels.
	(g) Types and features of offhand wheel dressers e.g. star type, etc.
	(h) Selection of the correct wheel for the tool.
	(i) Methods of using the bench grinder for spark testing materials.
	(j) Surface finish obtainable.
	(k) Grinding procedures.
	(l) Methods of grinding a form offhand.
	(m) Methods of grinding the common hand tools.
	(n) Precautions re overheating (burning) tools.
	(o) Methods of providing adequate lighting of the machine.
	(p) Safety practice-position of work rest close to wheel to protect fingers, etc.
	(q) Precautions re work jamming between work rest and wheel.

BLOCK VIII: GRINDING PRACTICE

UNIT 4: SURFACE GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Grinding a plane surface	(a) Methods of mounting work as B10, U2, O2, 4.
Work held: in a vise on a magnetic chuck	(b) Method of selecting the correct machine for the grinding operation.
	(c) Types, features and functions of reciprocating surface grinders.
	(d) Types, features and functions of rotary type surface grinders.
	(e) Types and features of horizontal spindle machines.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 4: SURFACE GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd	<ul style="list-style-type: none"> (f) Types and features of vertical spindle machines. (g) Types, features and classification of grinding wheels suitable for plain surface grinding. (h) Standard grinding wheel markings. (i) Standard grinding wheel shapes. (j) Types and features of segmental wheel chucks. (k) Selecting suitable wheel. (l) Amount of material that can be removed at each pass. (m) Types of finish obtainable. (n) Methods of dressing grinding wheels. (o) Types, features and functions of star wheel dressers. (p) Types, features and functions of diamond wheel dressers. (q) Grinding speeds. (r) Amount of feed per pass. (s) Methods of diagnosing and correcting grinding troubles. (t) Methods of supporting thin work to prevent distortion. (u) Methods of checking and testing magnetic chuck surfaces. (v) Methods of applying coolants and lubricants. (w) Methods of recirculating coolant. (x) Methods of removing swarf from coolant. (y) Methods of refinishing chuck surface. (z) Precautions re leaving swarf on chuck -- keeping chuck clean. (aa) Methods of grinding quantity parts, small pieces. (ab) Methods of rough and finish grinding. (ac) Methods of supporting distorted thin work on a magnetic chuck. (ad) Methods used to prevent burning and checking. (ae) Methods of avoiding scratches on the work. (af) Methods of preventing work from sliding or spinning on magnetic chuck. (ag) Methods of mounting and dismounting surface grinder wheels.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 4: SURFACE GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd	<ul style="list-style-type: none"> (ah) Production methods. (ai) Types and uses of demagnetizing equipment. (aj) Safety practices - stand aside when starting wheels; use of goggles, face shields, etc. (ak) Grinding procedures. (al) Accuracy and finish obtainable. (am) Recognition of standard drafting finish symbols. (an) Types, features and functions of precision measuring instruments, gauges, etc.
2. Grinding a plane surface	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O4. (b) Types of work requiring table mounting. (c) Methods of testing grinding wheels before mounting e.g. ring test. (d) Methods of clamping work to the table. (e) Methods of truing up work. (f) Methods of determining when a coolant is required. (g) Methods of keeping work square. (h) Types, features and functions of wheel mountings. (i) Reasons for using wheel blotters. (j) Precautions re using wheel suitable for correct spindle speed. (k) Wheel dressing procedures. (l) Grinding procedures. (m) Safety practices re starting wheel, eye protection, etc.
Work held: on the table	

BLOCK VIII: GRINDING PRACTICE

UNIT 5: CYLINDRICAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Grinding a parallel cylinder	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O3. (b) Types, features and functions of cylindrical grinders. (c) Types and specifications of wheels used on cylindrical grinders. (d) Methods used for wheel balancing.
Work held: on centers on a mandrel	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 5: CYLINDRICAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd	<ul style="list-style-type: none"> (e) Methods of mounting and dismounting cylindrical grinding wheels. (f) Methods of handling and storing grinding wheels. (g) Methods of dressing wheels. (h) Number of times wheel requires dressing. (i) Accuracy and finish obtainable. (j) Method of determining correct work speed. (k) Types and features of work rests used on long thin work. (l) Amount of stock removed with each pass. (m) Recognition of glazed or loaded wheels. (n) Factors that affect the rate of production. (o) Method of determining suitable feed and speeds. (p) Safety practices re - stand aside when starting wheel; use of goggles, face shields, etc. (q) Grinding procedures. (r) Types, features and use of precision measuring instruments, gauges, etc.
2. Grinding a tapered spindle	<ul style="list-style-type: none"> (a) Method of mounting work as B10, U2, O3. (b) Types of work requiring taper grinding. (c) Methods of setting up work to grind a taper. (d) How variations in work diameter will affect cutting speed. (e) Methods of arriving at correct wheel speed. (f) Methods of determining when a wheel requires dressing. (g) Methods of calculating tapers. (h) Methods of checking and testing tapers. (i) Types and features of taper gauges. (j) Precautions re sticking gauges. (k) Methods of fitting tapers. (l) Grinding procedures. (m) Types, features and care of precision measuring instruments. (n) Types and uses of high spot indicators e.g. prussian blue, etc.
Work held: on centers on a mandrel	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 5: CYLINDRICAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd	<ul style="list-style-type: none"> (o) Amount of lap in wheel feed per revolution of work. (p) Method of selecting the correct grade of wheel. (q) Wheel dressing procedures. (r) Accuracy and finish obtainable. (s) Care and storage of precision measuring tools, instruments, etc.
3. Grinding a complicated shape	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O3. (b) Types of work classed as complicated shapes e.g. crank shaft, contoured form, etc. (c) Speeds and feeds. (d) Methods of dressing form grinding wheels. (e) Wheel dressing procedures. (f) Methods of locking table traverse when plunge grinding. (g) Shapes of wheels suitable for this type of grinding. (h) Methods of testing and checking work contour. (i) Methods of "crush" dressing formed wheels. (j) Speeds for crush dressing. (k) Methods of testing wheel contours. (l) Production methods. (m) Methods of compensating for wheel wear. (n) Methods of determining work speed. (o) Methods of determining amount of work or wheel traverse. (p) Factors governing wheel wear. (q) Recognition of loaded or glazed wheels. (r) Factors governing grade of wheel. (s) Diagnosis and correction of cylindrical grinding troubles. (t) Methods of avoiding chatter marks on work. (u) Type of finish obtainable. (v) Methods of grading surface finishes. (w) Methods of supporting long work. (x) Methods of measuring wheel speeds. (y) Types, features and functions of tachometers and speed indicators. (z) Automatic measuring devices used on production grinders.
Work held: on centers on a mandrel	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 5: CYLINDRICAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd	<ul style="list-style-type: none"> (aa) Methods used in balancing grinding wheels. (ab) Methods used to avoid marks caused by machine vibration. (ac) Methods used to prevent vibration being transmitted from other machines. (ad) Types and features of work rests. (ae) Methods used in balancing revolving work or machine parts. (af) Calculating wheel surface speeds.

BLOCK VIII: GRINDING PRACTICE

UNIT 6: INTERNAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Grinding a straight through hole Work held: in a chuck	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O2. (b) Types of work requiring internal grinding e.g. bushings, gauges, etc. (c) Types of wheels and mounted points used for internal grinding. (d) Internal grinding wheel speeds. (e) Internal grinding work speeds. (f) Types and features of machines used for internal grinding. (g) Amount of traverse in internal grinding. (h) Methods of applying coolants. (i) Reasons for grinding work wet or dry. (j) Methods of checking and testing bores. (k) Methods of preventing distortions due to overheating. (l) Swarf disposal methods. (m) Safety practices re standing aside when starting wheel; use of goggles, face shields, etc. (n) Direction of rotation of wheel and work. (o) Accuracy and finish obtainable (p) Grinding procedures. (q) Preparation of work. (r) Types, features and use of precision measuring instruments, gauges, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 6: INTERNAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Grinding a tapered through hole</p> <p>Work held: in a chuck</p>	<p>(a) Methods of mounting work as B10, U2, O2.</p> <p>(b) Types of work requiring internal taper grinding e.g. taper gauges, etc.</p> <p>(c) Methods of setting machine to grind taper.</p> <p>(d) Methods used in checking and testing taper bores.</p> <p>(e) Types and features of instruments used for testing taper bores.</p> <p>(f) Accuracy and finish obtainable.</p> <p>(g) Methods of determining the correct wheel for internal grinding.</p> <p>(h) Methods of dressing internal grinding wheels.</p> <p>(i) Grinding procedures.</p> <p>(j) Precautions re sticking gauges.</p> <p>(k) Precautions re size of wheel jamming in small end.</p> <p>(l) Preparation of work for taper grinding.</p>
<p>3. Grinding a straight or tapered blind hole</p> <p>Work held: in a chuck</p>	<p>(a) Methods of mounting work as B10, U2, O2.</p> <p>(b) Types of work requiring ground blind bores.</p> <p>(c) Methods of grinding to the bottom of a blind hole.</p> <p>(d) Methods used to assure a sharp corner between sides and bottom.</p> <p>(e) Methods of dressing wheels.</p> <p>(f) Methods of measuring bores.</p> <p>(g) Types and features of instruments used to measure bores.</p> <p>(h) Surface finish obtainable.</p> <p>(i) Methods of measuring depth of hole.</p> <p>(j) Types and features of depth measuring tools.</p> <p>(k) Grinding procedures.</p> <p>(l) Amount of material that can be removed per pass.</p> <p>(m) Precautions re bottoming.</p> <p>(n) Types and features of wheels for blind hole grinding.</p> <p>(o) Precautions re "bell-mouthing".</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 6: INTERNAL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Grinding a formed hole</p> <p>Work held: in a chuck in a fixture</p>	<p>(a) Methods of mounting work as B10, U2, O2, 4.</p> <p>(b) Types and features of work requiring formed surfaces in the bore e.g. ball races, etc.</p> <p>(c) Methods of crush dressing internal grinding wheels.</p> <p>(d) Methods of holding wheel shape.</p> <p>(e) Plunge cut grinding procedures.</p> <p>(f) Methods of checking and testing formed bores.</p> <p>(g) Methods of chip disposal.</p> <p>(h) Work speed when internal grinding a shape.</p> <p>(i) Internal grinding wheel specifications.</p> <p>(j) Types and features of mounted wheels for internal grinding.</p> <p>(k) Surface finish obtainable.</p> <p>(l) Methods used in measuring surface finish.</p> <p>(m) Amount of material that can be removed per pass.</p> <p>(n) Amount necessary for finish grinding.</p> <p>(o) Methods of applying grinding coolants.</p> <p>(p) Types, features and specifications of grinding coolants.</p> <p>(q) Methods of setting stops for production grinding.</p> <p>(r) Production methods.</p> <p>(s) Care and maintenance of internal grinding attachments.</p> <p>(t) Precautions re scratching work.</p> <p>(u) Precautions re burning and checking.</p> <p>(v) Precautions re overheating wheel.</p> <p>(w) Precautions re striking wheel when entering bore.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Grinding tools for:</p> <p>ferrous metals</p> <p>non-ferrous metals</p> <p>non-metallic materials</p>	<p>(a) Properties and characteristics of various materials.</p> <p>(b) Design of tool to cut various materials.</p> <p>(c) Design of tool for roughing and finishing.</p> <p>(d) Types, features and functions of gauges and templates.</p> <p>(e) Types, features and characteristics of wheels for grinding various tools.</p> <p>(f) Grinding procedures.</p> <p>(g) Effect of grinding heat on the tool (Physics - heat - metallurgy).</p> <p>(h) Precautions re crowding or jamming wheels.</p> <p>(i) Safety practices re flying particles; use of goggles, guards, face shields, etc.</p> <p>(j) Method of testing tools for cracks or checks.</p> <p>(k) The effect of tool finish on work finish.</p> <p>(l) Methods of wheel and belt grinding.</p> <p>(m) Methods of wet and dry grinding.</p> <p>(n) The theory of metal cutting.</p> <p>(o) Accuracy required.</p> <p>(p) Chip formation and control.</p> <p>(q) Precautions re setting fire by flying hot particles (sparks).</p>
<p>2. Grinding tools made of:</p> <p>carbon tool steel</p> <p>high speed steels</p> <p>stellite</p> <p>sintered carbides</p> <p>etc.</p>	<p>(a) Types, features and characteristics of various tool materials.</p> <p>(b) Types, features and characteristics of grinding wheels for various tools.</p> <p>(c) Types, features and functions of offhand grinders.</p> <p>(d) Procedures used in offhand grinding.</p> <p>(e) Types, features and functions of machine grinders.</p> <p>(f) Procedures used in machine grinding.</p> <p>(g) Types, features and functions of tool grinding fixtures.</p> <p>(h) Care and storage of grinding wheels.</p> <p>(i) Methods of testing grinding wheels.</p> <p>(j) Nomenclature and markings of grinding wheels.</p> <p>(k) Methods of dressing and truing grinding wheels.</p> <p>(l) Recognition and tests for various tool materials.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd	<ul style="list-style-type: none"> (m) Types, features and use of coolants. (n) Safety practices re use of rests, mounting and starting wheels, etc. (o) Special methods used when grinding carbides. (p) Surface finish required. (q) Chip formation and control. (r) Types and features of "chip breakers". (s) Types, features and use of hand hones. (t) Shape control in production grinding. (u) Precautions re overheating. (v) Precautions re quenching. (w) Speeds and feeds for grinding. (x) Recognition of loaded or glazed wheels.
3. Grinding a single point (lathe type) facing tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of facing tools for various tools and materials as B10, U8, 01, 2. (b) Tool design, profile and angles for roughing and finishing. (c) Tool design for infeed and outfeed. (d) Tool design for restricted areas. (e) Grinding procedures. (f) Tool design for right and left hand facing tools. (g) Tool design for facing to a shoulder. (h) Safety practices re use of goggles
4. Grinding a single point turning tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of turning tools for various tools and materials as B10, U8, 01, 2. (b) Tool design, profile and angles for roughing and finishing. (c) Tool design for right or left hand turning tools. (d) Tool design for turning in restricted areas. (e) Tool design for both right and left hand turning. (f) Tool design for turning to a shoulder. (g) Grinding procedures. (h) Safety practices re use of goggles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Grinding a single point boring tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, O1 and 2. (b) Tool design, profile and angles for roughing and finishing. (c) Tool design for infeed or outfeed boring. (d) Tool design for boring in restricted areas. (e) Tool design for boring to a shoulder. (f) Tool design for both infeed and outfeed boring. (g) Grinding procedures. (h) Safety practices re use of goggles. (i) Safety practices re burning fingers (small tools).
6. Grinding a single point external threading tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, O1 and 2. (b) Tool design, profile and angles for: roughing and finishing, left and right hand threads, threading to a shoulder. (c) Methods of grinding tools for various threads, such as: National form, Vee thread, Acme, Square, Brown and Sharpe, Buttress, Unified, etc. (d) Calculations for helix angle. (e) Methods of gauging tools for various threads. (f) Accuracy required. (g) Grinding procedures. (h) Finish required for threading tools. (i) Precautions re hand stoning (rounding edge). (j) Methods and procedures for grinding and honing. (k) Procedures when regrinding broken tools. (l) Methods of grinding patented type threading tools.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
7. Grinding a single point internal threading tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, O1, and 2. (b) Tool design, profile and angles for: roughing and finishing, left and right hand threads, threading to a shoulder. (c) Methods of grinding internal threading tools, such as: National Form, Vee Thread, Acme, Square, Brown and Sharpe, Buttress, Unified, etc. (d) Methods of gauging. (e) Grinding procedures. (f) Safety practices re burning fingers.
8. Grinding forming tool (lathe type) such as: plain circular tangential	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, O1, and 2. (b) Types, features and functions of forming tools. (c) Tool design and angles for roughing and finishing. (d) Grinding procedures. (e) Accuracy and finish required. (f) Precautions re hand stoning. (g) Methods of re-grinding. (h) Precautions re wedging when offhand grinding. (i) Calculations re circular tool profile. (j) Methods of forming grinding wheel face. (k) Safety practices, use of goggles, face shields, etc. when wheel forming and grinding. (l) Methods of grinding to a sharp corner. (m) Methods of testing profile.
9. Grinding (lathe type) parting, necking and grooving tools	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, O1, and 2. (b) Types, features and functions of parting, necking and grooving tools. (c) Grinding procedures. (d) Tool design for side and front clearance. (e) Tool design for roughing and finishing. (f) Methods of re-grinding tools.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
9. Cont'd.	<ul style="list-style-type: none"> (g) Tool design for chip disposal. (h) Methods of grinding spring type tools.
10. Grinding a trepanning (face grooving) tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of trepanning tools. (c) Grinding procedures. (d) Tool design for roughing and finishing, side and front clearance, chip disposal, etc.
11. Grinding a double or multiple point tool such as: boring turning facing grooving forming, etc.	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of double and multi point cutters. (c) Types and features of boring, turning, facing heads, etc. (d) Tool design and angles for roughing and finishing. (e) Methods of grinding cutters. (f) Methods of duplicating angles, profiles, etc. (g) Care when re-grinding.
12. Grinding combination tools, such as: turning and facing parting and chamfering boring and facing, etc.	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of combination tools. (c) Reasons for using combination tools. (d) Tool design. (e) Grinding procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
13. Grinding back-facing tools	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of back-facing tools. (c) Tool design and angles. (d) Methods of grinding. (e) Accuracy required. (f) Tool design for restricted areas. (g) Methods of mounting back-facers.
14. Grinding spot-facing tools	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of spot-facers. (c) Tool design and angles. (d) Grinding procedures. (e) Precautions re damaging pilot.
15. Grinding a fly-cutter	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of fly cutters. (c) Tool design, profile and angles. (d) Precautions re side and end clearances. (e) Grinding procedures.
16. Grinding general-purpose planer-type tools, right or left hand, internal or external	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of planer tools. (c) Tool design, profile and angles for: roughing and finishing, left or right hand planing, planing to a shoulder, planing in restricted areas, combination left and right hand planing. (d) Grinding procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
17. Grinding planer-type parting and grooving tools	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of parting and grooving tools. (c) Tool design. (d) Grinding procedures.
18. Grinding a planer-type forming tool	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of forming and formed tools. (c) Grinding procedures. (d) Methods of grinding to a sharp corner. (e) Methods of forming grinding wheel face. (f) Methods of re-grinding. (g) Precautions re wedging tool when grinding offhand. (h) Tool design and angles for roughing and finishing. (i) Accuracy required. (j) Methods of testing profile.
19. Grinding a drill, large or small, such as: twist straight flute spade formed end stepped combination oil hole and oil tube	<ul style="list-style-type: none"> (a) Types, features and characteristics of various tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of various drills. (c) Drill point design, profile and angles. (d) Methods of testing drill points e.g. templates, gauges, try-out, etc. (e) Methods of grinding formed-end drills. (f) Methods of testing formed-end drills. (g) Grinding procedures (h) Drill terminology and nomenclature. (i) Types and features of drill grinding machines and grinding fixtures. (j) Methods of honing drill points. (k) Accuracy and finish required. (l) Causes and method of correcting grinding errors. (m) Reasons for using special drill grinding machines.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 7: TOOL GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
20. Grinding a drill to thin the web	<ul style="list-style-type: none"> (a) Types, features and characteristics of tools and materials as B10, U8, and 01, 2. (b) Reasons for thinning the web. (c) Grinding procedures. (d) Types of grinding wheels suitable for web-thinning. (e) Precautions re wedging of drill.
21. Grinding hand tools such as: scrapers chisels screw drivers scribers center punches, etc.	<ul style="list-style-type: none"> (a) Types, features and characteristics of tools and materials as B10, U8, 01, and 2. (b) Types, features and functions of hand tools. (c) Offhand and machine grinding procedures. (d) Methods of honing. (e) Methods of testing. (f) Precautions re wedging tools between wheel and rest. (g) Safety practices re care in handling sharp tools. (h) Methods of holding tools when sharpening.

BLOCK VIII: GRINDING PRACTICE

UNIT 8: CUTTER GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Grinding a plain or helical milling cutter Work held: on centers	<ul style="list-style-type: none"> (a) Method of mounting work as B10, U2, 03. (b) Types of wheels used for cutter grinding for land contour e.g. plain, cup etc. (c) Selecting the correct wheel for the job e.g. grade grain, etc. (d) Methods of measuring cutting speeds by using tachometers, etc. (e) Handling and care of grinding wheels. (f) Methods of obtaining the correct cutting speed. (g) Belt and pulley calculations to get correct cutting speed. (h) Grinding wheel structure bond, grain, grade, etc. (i) Method of mounting the grinding wheel. (j) Safety practices - testing wheel for soundness e.g. ring test.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 8: CUTTER GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (k) Method of truing and dressing wheel. (l) Types, features and functions of grinding wheel dressers. (m) Care and storage of diamond wheel dressers. (n) Types and features of tooth rests. (o) The correct position to support the tooth. (p) Method of holding cutter against tooth rest. (q) Method of setting table stops. (r) Methods used to equalize grinding wheel wear e.g. rotating the work half turn. (s) Methods of testing cutters. (t) Amount of material removed in roughing cuts. (u) Amount of material to remove when finish grinding. (v) Direction of wheel rotation. (w) Reasons for grinding on or off the cutting edge. (x) Method of setting the cutter to grind correct clearance. (y) Standard equipment used in clearance setting and centering cutters (e.g. setting dial). (z) Tables for determining the correct clearance angles. (aa) Amount of feed to use when grinding. (ab) The effect of wheel shape on clearance angle. (ac) Cutter nomenclature and terminology. (ad) Types and features of arbors used to support cutters. (ae) Reasons for wet or dry grinding. (af) Materials used in the manufacture of plain and helical milling cutters. (ag) Safety practices - stand aside when starting wheel; use of goggles or face shields. (ah) Correct use of guards to protect operator from flying pieces. (ai) Grinding procedures. (aj) Types of cutters sharpened on the periphery. (ak) Calculation for height of tooth rest for clearance angle. (al) Recognition of loaded or glazed wheels. (am) Features and functions of plain milling cutters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 8: CUTTER GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	(an) Types, features and use of slab milling cutters.
2. Grinding a stagger-tooth milling cutter	(a) Method of mounting work as B10, U2, 03, 4. (b) Types of tooth rests used in grinding stagger tooth cutters.
Work held: on centers on a fixture	(c) Effect of grinding heat on the cutters (Physics-heat). (d) Types and features of cutter gauges and templates. (e) Design of cutter to cut various materials. (f) Use and care of diamond wheels. (g) Methods of approaching wheel and rest when grinding stagger teeth. (h) Methods of setting up to grind sides. (i) Types of tooth rests used when grinding side teeth. (j) Methods of mounting cutter when grinding side teeth e.g. stub arbor. (k) Grinding procedures.
3. Grinding a face milling cutter	(a) Method of mounting work as B10, U2, 04. (b) Types and features of face milling cutters. (c) Design of teeth on face milling cutters.
Work held: on a fixture	(d) Design of arbors used to support face mill cutters. (e) Cutter nomenclature. (f) Grinding procedures. (g) Methods of setting cutter for grinding corners. (h) Methods of checking cutter for runout. (i) Amount of material removed per pass. (j) Care, use and storage of dial indicators and other test equipment. (k) Methods of avoiding burning teeth when grinding. (l) Methods of finishing e.g. honing, etc. (m) Methods of testing finished cutter. (n) Accuracy and finish required.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 8: CUTTER GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Grinding an angular cutter</p> <p>Work held: on a fixture</p>	<p>(a) Method of mounting work as B10, U2, O4.</p> <p>(b) Types and features of angular milling cutters.</p> <p>(c) Methods of obtaining the correct clearance angle</p> <p>(d) Wheel shapes usually used when grinding angular cutters.</p> <p>(e) Grinding procedures.</p> <p>(f) Method of setting tooth rest.</p> <p>(g) Method of testing ground surfaces.</p> <p>(h) Precautions re burning sharp point of cutter.</p>
<p>5. Grinding a formed cutter</p> <p>Work held: on a fixture</p>	<p>(a) Methods of mounting work as B10, U2, O4.</p> <p>(b) Types and features of formed milling cutters.</p> <p>(c) Types of cutter sharpened on a radial face.</p> <p>(d) Types and features of grinding wheels used for radial grinding.</p> <p>(e) Types, features and functions of master forms.</p> <p>(f) Methods of using master forms as a guide for tooth rest.</p> <p>(g) Methods of setting up cutter if master form is not available.</p> <p>(h) Methods of setting cutter to obtain correct rake angle.</p> <p>(i) Methods of testing cutter for correct shape after grinding.</p> <p>(j) Methods of controlling tooth spacing.</p> <p>(k) Reasons for grinding backs of teeth on new cutters.</p> <p>(l) Grinding procedures.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 8: CUTTER GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Grinding a hob	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O3, 4. (b) Types, features and functions of hobs. (c) Types of grinding wheels used to sharpen hobs. (d) Method of aligning hob for grinding. (e) Method of adjusting cutter for each additional grind. (f) Method of testing hob after grinding. (g) Grinding procedures. (h) Types of tooth rests used. (i) Grinding wheel speeds for grinding hobs.
Work held: on centers on a fixture	
7. Grinding sintered carbide tipped cutters	<ul style="list-style-type: none"> (a) Types, features and functions of sintered carbide cutters. (b) Reasons for tipping with sintered carbide. (c) Types and features of wheels used on carbide e.g. green grit wheel, diamond. (d) Preparation of cutters for grinding. (e) Amount of stock that can be removed for rough grinding. (f) Amount of stock left for finishing. (g) Grinding procedures. (h) Factors governing the selection of wheels. (i) Cutting speeds for diamond wheels. (j) Methods of checking and testing diamond wheels for run-out. (k) Types, features and functions of dial test equipment. (l) Methods of dressing diamond wheels. (m) Methods of inspecting carbide tips for cracks. (n) Types and features of inspection microscopes. (o) Correct direction for grinding carbide tips. (p) Methods of honing cutters after grinding. (q) Reasons for sharpening carbide cutters wet. (r) The advantages of wet grinding. (s) Precautions re overheating carbide tips or diamond wheels. (t) Diamond grinding wheel markings.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 9: CUTOFF GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cutting off stock by grinding.	(a) Methods of mounting work as B10, U2, 04 and 5.
Work held:	(b) Types and features of cutoff grinding wheels.
in a fixture	(c) Bonds used in cutoff grinding wheels.
in a vise	(d) Coolants used in cutoff grinding.
offhand	(e) Wheel speeds recommended.
	(f) Amount of feed desirable.
	(g) Grit and grade of wheel recommended for various materials.
	(h) Necessity for holding stock rigidly.
	(i) Precautions re jamming of wheel.
	(j) Power required for abrasive cutoff.
	(k) Types of work usually requiring abrasive cutoff.
	(l) Causes of faulty cutting.
	(m) Types, features and functions of guards, shields, etc.
	(n) Methods of preventing discoloration.
	(o) Causes of burrs and methods of correction.
	(p) Reasons for wet or dry cutoff.
	(q) Advantages of submerged cutting.
	(r) Wheel feed in relation to wheel wear.
	(s) Types and features of low speed cutoff machines.
	(t) Types and features of high speed cutoff machines.
	(u) Portable equipment used in abrasive cutoff.
	(v) Methods of correcting runout on abrasive wheels.
	(w) Types and features of diamond abrasive cutoff wheels.
	(x) Specifications of abrasive cutoff wheels.
	(y) Grinding procedures.
	(z) Methods of calculating cutoff wheel speeds.
	(aa) Types, features and functions of wheel speed indicators
	(ab) Methods of cutting off stock by nicking on corner of plain wheel and breaking.
	(ac) Safety practice re use of goggles, face shields, etc.
	(ad) Precautions re hardening tool steel by cutting and quenching.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 10: MISCELLANEOUS GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Using coated abrasives, such as belts.	<ul style="list-style-type: none"> (a) Types and features of coated abrasives. (b) Methods of classification of abrasive belts. (c) Types of grain spacing used on belts. (d) Types and beatures of backings used for abrasive belts. (e) Types of adhesives used on either wet or dry belts. (f) Abrasive materials used in the manufacture of belts. (g) Method of marking belts for identification of abrasive. (h) Uses for abrasive belts. (i) Types of surface finish obtainable. (j) Operating speeds for abrasive belts. (k) Types of coolants used with abrasive belts. (l) Methods of applying coolants. (m) Types and features of contact wheels. (n) Types and features of belt greases. (o) Methods of applying belt grease. (p) Types and features of abrasive belt machines. (q) Types and features of backstand idlers. (r) Methods of converting existing equipment for abrasive belts. (s) Methods of eliminating or controlling dust. (t) Types of abrasive belts used for wet grinding. (u) Operating precautions re cutting belt with sharp edges. (v) Safety practice: (a) use of goggles, face shields, guards, etc., (b) precautions re burning fingers, (c) precaution re belt running off contact wheel. (w) Grinding procedures.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 10: MISCELLANEOUS GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Using coated abrasives such as mounted discs	<ul style="list-style-type: none"> (a) Types and features of coated abrasives used in the manufacture of discs. (b) Methods of classification of abrasive discs. (c) Types and features of machines using abrasive discs. (d) Uses for abrasive discs. (e) Methods of mounting discs. (f) Cutting speeds for discs. (g) Advantages of using abrasive discs. (h) Types and features of adhesives used on discs. (i) Types of surface finish obtainable. (j) Methods of applying coolants. (k) Types and features of backing plates used with discs. (l) Methods of attaching abrasive to backing plate. (m) Types, features and functions of flexible abrasive discs. (n) Types, features and use of flexible disc mountings. (o) Types and uses of portable disc grinders.
3. Using mounted abrasive drums, cones, etc.	<ul style="list-style-type: none"> (a) Types, features and functions of mounted drums, cones, etc. (b) Methods of mounting drums, cones, etc. (c) Grinding procedures. (d) Types, features and functions of expanding mandrels. (e) Reasons for using drums, cones, etc. (f) Types and uses of portable grinders, attachments for portable drills, etc. (g) Operating precautions re nicking and slicing drums on sharp edges. (h) Safety practices re jamming cones and discs in corners, sharp curves, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 10: MISCELLANEOUS GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Lapping surfaces</p> <p>Work held: in a chuck on centers on a fixture by hand</p>	<p>(a) Methods of mounting work as B10, U2, O2, 3, 4, 5.</p> <p>(b) Reasons for lapping surfaces.</p> <p>(c) Types and features of abrasives used in lapping compounds.</p> <p>(d) Methods of grading abrasives for lapping.</p> <p>(e) Preparation of work for lapping.</p> <p>(f) Speeds for lapping.</p> <p>(g) Methods of charging laps.</p> <p>(h) Amount of material that can be removed by lapping.</p> <p>(i) Types and features of lapping lubricants.</p> <p>(j) Types, features and functions of laps.</p> <p>(k) Methods of adjusting laps.</p> <p>(l) Accuracy and finish obtainable by lapping.</p> <p>(m) Methods of applying abrasive to laps.</p> <p>(n) Speeds and feeds for lapping.</p> <p>(o) Types and features of disc laps.</p> <p>(p) Diagnosis and correction of lapping troubles.</p> <p>(q) Pressures required in lapping.</p> <p>(r) Methods of lapping a flat face.</p> <p>(s) Methods of cleaning laps.</p> <p>(t) Materials used in making laps.</p> <p>(u) Methods of making laps.</p> <p>(v) Diagnosis and control of lapping errors.</p> <p>(w) Methods of preventing scoring.</p> <p>(x) Care and storage of laps.</p> <p>(y) Care and storage of abrasives.</p> <p>(z) Recognition of standard drafting finish symbols.</p>
<p>5. Honing surfaces</p> <p>Work held: in a chuck on centers on a fixture by hand</p>	<p>(a) Methods of mounting work as B10, U2, O2, 3, 4.</p> <p>(b) Reasons for honing.</p> <p>(c) Types and features of hones.</p> <p>(d) Methods of mounting hones.</p> <p>(e) Types of work requiring honing.</p> <p>(f) Speeds for honing.</p> <p>(g) Types and features of honing lubricants.</p> <p>(h) Methods of dressing hones.</p> <p>(i) Methods of cleaning hones.</p> <p>(j) Amount of material that can be removed by honing.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK VIII: GRINDING PRACTICE

UNIT 10: MISCELLANEOUS GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Cont'd.	<ul style="list-style-type: none"> (k) Methods of driving hones. (l) Theory of honing. (m) Surface finish obtainable by honing. (n) Care and storage of hones. (o) Precautions re seizing of hones in bores. (p) Methods of using sheet abrasives for honing. (q) Diagnosis and control of honing errors. (r) Care and storage of hones. (s) Honing procedures.
6. Polishing surfaces	<ul style="list-style-type: none"> (a) Methods of mounting work as B10, U2, O2, 3, 4, 5. (b) Reasons for polishing. (c) Types and features of abrasives used for polishing. (d) Methods of grading polishing compounds. (e) Methods of mounting and holding polishing cloths and papers, etc. (f) Speeds for polishing. (g) Types and features of polished surfaces. (h) Types and features of polishing lubricants. (i) Methods of applying polishing lubricants. (j) Methods flat face polishing. (k) Methods of polishing contours. (l) Allowances for polishing. (m) Classification of surface finishes. (n) Methods of measuring surface finish. (o) Types and features of instruments for measuring surface finish. (p) Operating precautions re discoloration of work by heat. (q) Precautions re rounded corners. (r) Methods of handling and storing abrasive cloths and papers. (s) Polishing techniques -dry or grease method. (t) Safety practices--trail work to wheel, stand aside, use face shields or goggles, etc. (u) Methods of setting up polishing wheels and bobs. (v) Precautions re setting fire by flying hot particles (sparks). (w) Polishing procedures.

Work held:

in a chuck
on centers
on a fixture
by hand

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX - SAWING PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	258
Unit 2. Circular Sawing Techniques.....	259
Unit 3. Reciprocating Sawing Techniques.....	261
Unit 4. Band Sawing Techniques.....	264

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	(a) Names and functions of machine parts. (b) Kinds, uses and selection of lubricant. (c) Lubricating procedures. (d) Types, features and use of lubricating equipment. (e) Precautions re over lubricating motors.
2. Controlling the machine	(a) Types, features and functions of primary control mechanisms. (b) Types, features and functions of secondary controls. (c) Types and features of coolant system controls. (d) Methods of controlling speeds and feeds.
3. Cleaning the machine	(a) Types and uses of cleaners and solvents. (b) Cleaning procedures. (c) Cleaning frequency. (d) Methods of cleaning coolant tanks, pipes, filters, etc. (e) Safety practices (hygiene, accidents). (f) Precautions re use of air hose.
4. Adjusting the machines	(a) Methods of adjusting moving parts. (b) Methods of compensating for wear. (c) Types, features and use of tools for adjustments. (d) Methods of adjusting clutches. (e) Need for periodic checks. (f) Precautions re overtightening gibs. (g) Precautions re replacing guards and safety devices. (h) Methods of adjusting blade tensions. (i) Types, features and adjustment of blade guides and backup bearings on band saws. (j) Method of making band saws "track".

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 2: CIRCULAR SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Sawing stock on the table-type saw from bar, tubing and extruded stock	<ul style="list-style-type: none"> (a) Types, features and functions of table saws e.g. moving blade and moving work types. (b) Methods of holding stock. (c) Methods of supporting long stock e.g. roller tables, skids, etc. (d) Types, features and specifications of circular saw blades. (e) Methods of mounting blades. (f) Methods of feeding work e.g. hand and power. (g) Speeds for sawing various materials such as: ferrous, non-ferrous and non-metallic materials. (h) Feeds for various types of work. (i) Types and uses and application of cutting compounds. (j) Accuracy obtainable. (k) Sawing procedures. (l) Finish obtainable. (m) Methods of measuring stock. (n) Production methods stock stops, gauging, etc. (o) Operating precautions re binding, over-feeding, etc. (p) Safety practices re flying particles, revolving saw, kicking and jamming of work, spinning of work. (q) The theory of sawing. (r) Methods of sawing work at specific angles. (s) Methods of setting fence and/or holding devices at an angle. (t) Methods of measuring angles. (u) Types, features of holding devices e.g. vises, clamps, jigs, etc.
2. Sawing stock on a radial arm circular saw from bar, tubing and extruded stock	<ul style="list-style-type: none"> (a) Types, features and functions of radial arm saws. (b) Methods of holding stock as vise, clamps, jigs, fixtures, by hand, etc. (c) Methods of supporting long stock such as tables, horses, etc. (d) Methods of mounting saws. (e) Methods of feeding saw: power and hand feed. (f) Feeds for various types of work and materials.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 2: CIRCULAR SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (g) Radial arm sawing procedures. (h) Methods of measuring stock. (i) Production methods stock stops, gauging, etc. (j) Direction of rotation of saw. (k) Precautions re binding, over-feeding, etc. (l) Methods of sawing work at specific simple angles. (m) Methods of sawing work at specific compound angles. (n) Methods of setting saw to simple and compound angles. (o) Safety practices re rotating and advancing saw, flying particles. (p) Reason for sawing on radial arm saw.
3. Sawing off work on a hand mill	<ul style="list-style-type: none"> (a) Types, features and functions of hand mills. (b) Type of work usually machined on a hand mill such as bars, tubes, extruded shapes, structural shapes, etc. (c) Methods of holding work. (d) Sawing procedures. (e) Speeds and feeds. (f) Direction of saw rotation and direction of feed, conventional and climb milling. (g) Methods of feeding work or arbor. (h) Methods of mounting cutters. (i) Types, features and use of cutters. (j) Finish and accuracy obtainable. (k) Reasons for using hand mill. (l) Methods of positioning work under cutter. (m) Sawing to a layout. (n) Production methods: stock stops, hydraulic and mechanical quick acting vises, gauging work, etc. (o) Types and features of special vise jaws. (p) Use of jigs and fixtures. (q) Method of holding and clamping odd shaped work. (r) Safety practices re sharp fins, burrs, etc. (s) Methods of setting, measuring and sawing specific angles. (t) Types, features and application of coolant.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 2: CIRCULAR SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Sawing slots in stock on a production mill	<ul style="list-style-type: none"> (a) Types of work usually slotted or grooved on a production mill, such as screw slots, clamping slots, keyways collets, etc. (b) Types and uses of sawn slots and grooves. (c) Methods of holding work. (d) Slotting procedures. (e) Methods of measuring and gauging depth and length of slots and grooves. (f) Finish and accuracy obtainable. (g) Speeds and feeds. (h) Reasons for slotting on production mill. (i) Types and uses of special holding equipment. (j) Methods of indexing work. (k) Operating precautions re saw striking holding devices. (l) Production methods: use of jigs and fixtures, special jaws, quick acting clamps, etc.

BLOCK IX: SAWING PRACTICE

UNIT 3: RECIPROCATING SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cutting stock on a horizontal reciprocating saw	<ul style="list-style-type: none"> (a) Types, features and functions of wet and dry saws. (b) Methods of holding stock. (c) Methods of supporting long stock. (d) Types, features and functions of saw blades for various uses. (e) Methods of mounting blades. (f) Methods of feeding saw e.g. mechanical, hydraulic, gravity, etc. (g) Methods of varying rate of feed. (h) Methods of varying speed of saw i.e. number of strokes per minute. (i) Tension required for blades. (j) Speeds and feeds for various materials. (k) Types, characteristics and application of cutting compounds. (l) Methods of controlling rate of coolant flow. (m) Types and features of coolant circulating systems.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 3: RECIPROCATING SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (n) Methods of driving coolant pump. (o) Methods of cleaning coolant sumps, pumps, filters and lines. (p) The theory of sawing. (q) Methods of controlling saw e.g. primary and secondary controls. (r) Methods of adjusting clutch. (s) Accuracy and finish obtainable. (t) Types of work usually sawn on a reciprocating saw. (u) Sawing procedures. (v) Methods of measuring stock. (w) Production methods, stock stops, ganging, etc. (x) Methods of plain angular sawing. (y) Methods of setting holding equipment for simple angles. (z) Methods of setting and testing compound angles. (aa) Methods of measuring angles simple and compound. (ab) Types, features and functions of angle and length measuring tools. (ac) Types, features and functions of work holding equipment such as vise, clamps, fixtures, etc. (ad) Lighting, space and power requirements for saws. (ae) Types, features and location of stock racks. (af) Precautions re sawing thick and thin sections, tubular work etc. (ag) Method of preventing coolant loss e.g. splash guards drip pans when sawing tubes, channels, ganged work, etc. (ah) Precautions re jamming saw in thin sections, gummy materials etc. (ai) Precautions re blade breakage when starting cut, thin sections, etc. (aj) Methods of mounting blades. (ak) Methods and frequency of cleaning and lubricating. (al) Safety practices re falling stock, falling saw, reciprocating saw, open crank, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 3: RECIPROCATING SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Sawing stock on a vertical reciprocating saw	<ul style="list-style-type: none"> (a) Types of work sawn on a vertical reciprocating saw. (b) Types, features and functions of vertical reciprocating saws. (c) Types, features and use of blades for various jobs. (d) Methods of sawing to a layout. (e) Types and uses of blades for contour sawing. (f) Methods of supporting saws for various jobs. (g) Methods of feeding work. (h) Methods of holding work down. (i) Types and features of pressure feet. (j) Types and features of blade guides and back supports. (k) Types and features of blowers for removing chips. (l) Methods of setting and tensioning blades. (m) Tension required for blades. (n) Speeds of saw for various jobs. (o) Methods of starting cut. (p) Methods of internal sawing. (q) Preparation of work for internal sawing. (r) Production methods; stacking, pattern sawing, etc. (s) Methods of tilting table for angular sawing. (t) Accuracy and finish obtainable. (u) Lighting and power requirements. (v) Precautions re jamming saw on tight curves. (w) Recommended blade widths for various radii. (x) Operating precautions re blade breakage (over-feeding, insufficient tension, etc.) (y) Safety practices re hot chips, moving blade, etc. (z) Methods of setting saw guides and back supports.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 4: BAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Sawing stock on a horizontal band saw	<ul style="list-style-type: none"> (a) Types, features and functions of horizontal band saws. (b) Types of work usually cut on a horizontal band saw. (c) Methods of holding stock. (d) Methods of supporting long stock. (e) Types, features and use of blades for various jobs. (f) Methods of mounting saws. (g) Methods of feeding saw. (h) Method of varying rate of feed. (i) Speeds for various materials. (j) Methods of varying speed. (k) Tension required for blades. (l) Types, characteristics and applications of cutting compounds. (m) Speeds for wet and dry saws. (n) Methods of controlling coolant flow. (o) Types and features of coolant circulating systems. (p) Method of cleaning coolant sumps, pumps, filters and lines. (q) Methods of controlling saw, primary and secondary controls. (r) Sawing procedures. (s) Production methods, stock stops, ganging, etc. (t) Methods of sawing angles. (u) Methods of testing and measuring angles, simple and compound. (v) Types and uses of work holding devices. (w) Lighting, space and power requirements for saw. (x) Types, features and location of stock racks. (y) Methods of preventing coolant loss. (z) Methods and frequency of cleaning and lubricating. (aa) The theory of band sawing. (ab) Precautions re blade breakage jamming, run out, over feeding, starting cut. (ac) Safety practices re falling stock, moving saw blade, falling saw head, flying particles. (ad) Diagnosis and correction of sawing troubles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 4: BAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Stock cut off on a vertical band saw	<ul style="list-style-type: none"> (a) Types, features and functions of vertical band saws. (b) Methods of setting up stock for cut off work. (c) Types and features of blades for cut off work. (d) Speeds for sawing various materials. (e) Methods of changing speeds. (f) Feeds for sawing. (g) Methods of feeding work. (h) Methods of supporting work e.g. fence, vise, hand etc. (i) Blade tension required. (j) Methods of mounting and tensioning blades. (k) Methods of setting blade guides and back supports. (l) Types of blade for various materials. (m) Method of controlling saw. (n) Sawing procedures. (o) Production methods, stock stops, ganging, stacking etc. (p) Methods of setting sawing and measuring angles. (q) Lighting space and power requirements. (r) Factors governing maximum length of stock. (s) Prevention and correction of saw "wander". (t) Types of work sawn on vertical band saws. (u) Limitations of the vertical band saw. (v) The theory of band sawing. (w) Methods of joining band saw blades.
3. Stock cut off on a band type friction saw	<ul style="list-style-type: none"> (a) Types, features and functions of band type friction saws. (b) Methods of holding work. (c) Speeds for friction saw blades. (d) Feeds for work. (e) Methods of feeding work. (f) Types and features of guides and back supports. (g) Use and limitations of friction saws. (h) Types and features of friction saw blades. (i) Friction sawing procedures. (j) Methods of controlling saw. (k) Methods of mounting blades.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 4: BAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (l) Methods of setting sawing and measuring angles. (m) Lighting space and power requirements. (n) Operating precautions care re overfeeding. (o) Safety practices - hazard:- flying particles use of goggles, face shields, etc. moving saw, etc. (p) Height of back supports and blade guides. (q) The theory of friction sawing. (r) Method of joining blades. (s) Band tool terms and definitions.
4. Vertical band sawing a straight line in plate band or sheet materials	<ul style="list-style-type: none"> (a) Types, features and functions of various saw bands. (b) Selection of the correct blade for the job. (c) Speeds of blades for various materials. (d) Feeds for various jobs. (e) Methods of holding and feeding work. (f) Reasons for sawing on the band saw. (g) Precautions re backing out of cut. (h) Method of controlling blade speed. (i) Finish and accuracy obtainable. (j) Types of work sawn on band saws. (k) Time required for sawing. (l) Methods of measuring band lengths. (m) Methods of sawing tubes and special shapes. (n) Methods of sawing to a template. (o) Sawing to a layout. (p) Methods, tools and materials used in layout work. (q) Special purpose bands used when sawing cloth, leather, cork, plastics, paper products, etc. (r) Types of bands used in line grinding hardened materials e.g. hardened dies. (s) Types and uses of coolants. (t) Length of life of saw bands. (u) Care and storage of saw bands. (v) Lubrication of saw guides. (w) Methods of setting and adjusting saw guides.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 4: BAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Friction sawing a straight line in plate band or sheet materials	<ul style="list-style-type: none"> (a) Types, features and use of friction saw bands. (b) Speed for friction sawing. (c) Feeds used in friction sawing. (d) Methods of mounting and feeding work. (e) Type of work sawn on a friction saw. (f) Accuracy and finish obtainable. (g) Speed required for friction sawing. (h) Principles of the friction sawing. (i) Comparison of costs between standard sawing and friction saw. (j) Types of materials which can be sawn on friction saw. (k) Precautions re sawing thick material. (l) Length of life of friction saw bands. (m) Removal of burrs from bottom side of cut. (n) Method of setting and adjusting band saw guides. (o) Care and storage of blades. (p) Lubrication of saw guide. (q) Care and storage of blades. (r) Methods of sawing to a template. (s) Diagnosis and correction of friction sawing troubles.
6. Contour sawing plate and sheet material on a vertical band saw	<ul style="list-style-type: none"> (a) Types, features and functions of saw bands for contour sawing. (b) Use of precision saw bands. (c) Relation of gauge, set and band width to minimum radius. (d) Speeds and feeds for various materials and thicknesses. (e) Contour sawing procedures. (f) Types features and functions of spiral edge saw bands. (g) Reason for using spiral edge saw bands. (h) Methods of joining spiral edge saw blades. (i) Need for special saw guides. (j) Care and storage of spiral edge saw blades. (k) Direction of feed when using spiral edge saw blades. (l) Diagnosis and correction of band sawing troubles. (m) Production methods e.g. stacking, templates, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK IX: SAWING PRACTICE

UNIT 4: BAND SAWING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd.	(n) Types and uses of coolants and lubricants. (o) Precautions re sawing plastics and gummy materials.
7. Friction sawing a contour in plate or sheet material	(a) Types, features and use of saw bands for friction contour sawing. (b) Accuracy and finish obtainable. (c) Principles of contour friction sawing. (d) Contour sawing procedures. (e) Speeds and feeds for friction contour sawing.
8. Band sawing an internal contour on a vertical band saw	(a) Preparation of work for internal contour sawing. (b) Methods of cutting and joining saw bands. (c) Methods of cutting die blanks to save both punch and die pieces. (d) Comparative costs between band sawing and conventional methods of die making. (e) Methods of starting cut. (f) Method of setting table at required angle. (g) Selection of blade for internal contour sawing. (h) Safety practices re removal of centre section. (i) Operating precautions re jamming of blade. (j) Precautions re over-running layout.
9. Band sawing work at an angle, internal or external	(a) Methods of sawing at an angle. (b) Methods of tilting saw table. (c) Methods of gauging and measuring angles. (d) Precautions re sawing on right side of saw for correct angle. (e) Method of starting cut. (f) Precautions re allowing work to hang on blade. (g) Safety practices re moving saw blade.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X - PROPERTIES AND USES OF MATERIALS

TABLE OF CONTENTS

	PAGE
Unit 1. Physical Characteristics and Testing ...	270
Unit 2. Basic Ferrous Metals	272
Unit 3. Ferrous Alloys	277
Unit 4. Basic Non-ferrous Metals	282
Unit 5. Non-ferrous Alloys	285
Unit 6. Non-metallic Materials	289
Unit 7. Chemicals	294

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 1: PHYSICAL CHARACTERISTICS

OPERATIONS	KNOWLEDGE
1. Selecting materials by simple recognition	<ul style="list-style-type: none">(a) The appearance of materials such as, colour, texture, brightness, dullness, etc.(b) The comparative weights of materials e.g. light, medium or heavy.(c) The "feel" of materials e.g. smooth, slippery, rough, hard, soft, texture, etc.(d) The "smell" of materials e.g. the distinctive smell of acids, cyanides, woods, oils, etc.(e) The "sound" of materials when struck with hammer or dropped on concrete floor.(f) The need for further tests for some materials.(g) The value of experience in using simple recognition tests.(h) The advantages of knowing materials by simple recognition.(i) The limitations of the senses in testing materials.(j) Safety practices re inhaling toxic fumes, flying particles when struck, etc., testing poisonous materials.(k) Recognition by colour code.(l) Standard specifications by S.A.E. and A.I.S.I. codes.
2. Recognizing materials by simple tests	<ul style="list-style-type: none">(a) The spark test - the appearance of sparks thrown off by contact with an abrasive wheel.(b) The toughness test - the amount material will bend before fracturing.(c) The hardness test - comparative hardness using the file or other cutting tool.(d) The spring test - comparative "spring-back" when bent.(e) The brittleness test - comparative brittleness when struck or bent.(f) The endurance test - the number of times a material will bend before fracturing.(g) The hammer test - the amount of rolling or hammering before rupturing.(h) The stretch test - the amount a piece will stretch before fracturing.(i) The machining test - the ease of machining.(j) The corrosion test - the resistance to corrosion when subjected to corrosive chemicals or dampness.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 1: PHYSICAL CHARACTERISTICS

OPERATIONS

KNOWLEDGE

2. Cont'd.

- (k) The stiffness test - the comparative resistance to bending or twisting.
- (l) The melting test - the comparative melting points of materials.
- (m) The puddling test - the appearance of the puddle when welding metals.
- (n) The elevated temperature test - the resistance to collapse when hot.
- (o) The abrasive test - the amount one material will abrade another.
- (p) The polishing test - the appearance of a material after being polished.
- (q) The "form" test - selecting material by knowing its common form e.g. zinc die castings, iron castings, etc.
- (r) Testing procedures.
- (s) Heating and quenching to find out if materials harden, tool steels.
- (t) The need for experience when making simple tests.
- (u) Reasons for making simple tests and their limitations.
- (v) The need for more exacting tests for some metals.
- (w) Time required for tests.
- (x) Equipment necessary to make simple test.
- (y) Safety practices re care in handling and testing materials, acids, etc.
- (z) Simple chemical tests.

3. Recognizing materials by exacting tests

- (a) Types, features and functions of testing equipment.
- (b) Care, storage and use of testing equipment.
- (c) Testing procedures.
- (d) Methods of testing for various physical properties such as tensile strength, impact resistance, elevated temperature strength, fatigue resistance, hardness, ductility, malleability, elasticity, stiffness, toughness, machinability, weldability, corrosion resistance, endurance limit, melting point coefficients of expansion, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 1: PHYSICAL CHARACTERISTICS

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (e) The appearance of the fracture - texture, necking down, etc. (f) The character of the fracture e.g. necking down, cupping, etc. (g) Methods of testing "case" and "core" of case-hardened work to show depth of penetration and hardness of "case" and "core". (h) The cost of scientific testing. (i) Time required for exacting tests. (j) Chemical analysis for various materials. (k) Use and limitations of scientific testing. (l) The place of scientific testing in modern industry. (m) The value of scientific testing. (n) The machinist's role in scientific testing. (o) Conversion of S.A.E. and A.I.S.I. numbering systems.

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 2: BASIC FERROUS METALS

OPERATIONS	KNOWLEDGE
1. Selecting, identifying and using grey cast iron	<ul style="list-style-type: none"> (a) Methods of testing and identifying grey cast iron - B13, U1, O1, 2 and 3. (b) Characteristics and uses of grey cast iron. (c) The cost of cast iron. (d) The value of the knowledge of physical properties of cast iron such as: tensile, ductile, impact, strength, etc., use of handbook. (e) The heat treatment of cast iron e.g. annealing, normalizing, hardening, malleablizing, etc. (f) The manufacture of pig iron from iron ore. (g) Methods of refining, melting and casting. (h) The history and uses of cast iron. (i) Limitations of cast iron. (j) Allowable impurities for standard parts SAE Standards Handbook.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 2: BASIC FERROUS METALS

OPERATIONS

KNOWLEDGE

1. Cont'd.

- (k) The percentage of carbon in cast iron graphite and combined carbon.
- (l) Methods of preventing corrosion e.g. plating, hot tinning, galvanizing, painting, etc.
- (m) Methods of fabricating e.g. welding, brazing, riveting, bolting, etc., and limitations of each method.
- (n) Methods of forming hard areas - use of the "chill" when casting.
- (o) The effect of thick and thin sections on iron castings.
- (p) The amount of shrinkage of cast iron.
- (q) Reasons for using iron for castings e.g. mass, cost, ease of machining, ease of making intricate shapes, etc.
- (r) Calculation of weight of iron castings.
- (s) Recognition of cast iron section shading or symbols on blueprints or drawings.
- (t) Structure of cast iron.
- (u) Reasons for filletting castings.
- (v) Advantages and disadvantages of the hard skin on cast iron.

2. Selecting, identifying and using white cast iron

- (a) Methods of testing and identifying white cast iron - Bl3, Ul, Ol, 2 and 3.
- (b) Common uses of white cast iron.
- (c) Characteristics of white cast iron.
- (d) Reasons for using white cast iron.
- (e) The use of the knowledge of physical properties such as tensile strength, hardness, brittleness, etc., use of handbook.
- (f) Heat treatments possible for white cast iron.
- (g) Limitations and use of white cast iron.
- (h) Methods of machining white cast iron.
- (i) Methods of manufacturing white cast iron.
- (j) Carbon content of white cast iron.
- (k) Structure of white cast iron.
- (l) Methods of finishing.
- (m) Prevention of corrosion.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 2: BASIC FERROUS METALS

OPERATIONS	KNOWLEDGE
3. Selecting, identifying and using malleable iron	<ul style="list-style-type: none">(a) Methods of testing and identifying malleable iron as B13, U1, O1, 2 and 3.(b) Characteristics and uses.(c) Cost of malleable iron.(d) Reason for knowing the physical properties.(e) Methods of manufacturing malleable iron.(f) Heat treatments possible for malleable iron.(g) History of malleable iron.(h) Limitations of malleable iron.(i) Carbon content.(j) Methods of fabricating and machining.(k) Reasons for the use of malleable iron.(l) Recognition of malleable iron symbols on blueprints.(m) Structure of malleable iron.(n) Various forms of malleable iron.(o) Methods of finishing and corrosion prevention.
4. Selecting, identifying and using wrought iron	<ul style="list-style-type: none">(a) Methods of testing and identifying wrought iron as B13, U1, O1, 2 and 3.(b) Characteristics and uses.(c) Cost of wrought iron.(d) Use of the knowledge of physical properties.(e) Method of manufacture.(f) Heat treatments possible.(g) History of wrought iron.(h) Limitations of wrought iron.(i) Impurities usually found.(j) Structure of wrought iron.(k) Carbon content and form of carbon present.(l) Methods of fabricating and machining.(m) Reasons for use.(n) Recognition of symbols for wrought iron on blueprints.(o) Various forms of wrought iron.(p) Methods of finishing.(q) Forging temperature range.(r) Corrosion prevention.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 2: BASIC FERROUS METALS

OPERATIONS	KNOWLEDGE
<p>5. Selecting, identifying and using low carbon steel such as:</p> <p>mild steel machinery steel cold rolled steel etc.</p>	<p>(a) Methods of testing and identifying low carbon steel as B13, U1, O1, 2 and 3.</p> <p>(b) Characteristics and uses.</p> <p>(c) Cost of mild steel.</p> <p>(d) Various manufactured forms e.g. rod, sheet, plate, forgings, etc.</p> <p>(e) The use of the knowledge of physical properties.</p> <p>(f) Heat treatment possible.</p> <p>(g) Forging temperature range.</p> <p>(h) History and manufacture of mild steel.</p> <p>(i) Limitations and uses.</p> <p>(j) Allowable impurities SAE or AISI standards.</p> <p>(k) Carbon content and form of carbon present.</p> <p>(l) Structure of mild steel.</p> <p>(m) Methods of fabricating and machining.</p> <p>(n) Reasons for use.</p> <p>(o) Recognition of the symbols for low carbon steels on blueprints.</p> <p>(p) Methods of finishing.</p> <p>(q) Corrosion prevention.</p> <p>(r) Types, features and uses of various low carbon steels.</p> <p>(s) Forms in which cold rolled steel is produced.</p> <p>(t) Method of showing low carbon steel in cross section on blueprint.</p>
<p>6. Selecting, identifying and using medium carbon steel</p>	<p>(a) Methods of testing and identifying as B13, U1, O1, 2 and 3.</p> <p>(b) Characteristics and uses of medium carbon steel.</p> <p>(c) Cost of medium carbon steel.</p> <p>(d) Various manufactured forms.</p> <p>(e) Use of the knowledge of physical properties.</p> <p>(f) Heat treatments possible for medium carbon steels.</p> <p>(g) Forging and hardening temperature range.</p> <p>(h) History and manufacture.</p> <p>(i) Limitations and uses.</p> <p>(j) Allowable impurities SAE and AISI standards.</p> <p>(k) Carbon content and form of carbon present.</p> <p>(l) Structure of medium carbon steel.</p> <p>(m) Methods of fabricating and machining when hard or soft.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 2: BASIC FERROUS METALS

OPERATIONS

KNOWLEDGE

6. Cont'd.

- (n) Reasons for use.
- (o) Welding techniques.
- (p) Recognition of symbols for medium carbon steel on blueprints.
- (q) Method of finishing.
- (r) Corrosion prevention.
- (s) Method of showing medium carbon steel in cross section on blueprint.

7. Selecting, identifying
and using high carbon
tool steel

- (a) Methods of testing and identifying as B13, U1, O1, 2 and 3.
- (b) Characteristics and uses.
- (c) Cost of high carbon tool steel.
- (d) Various manufactured forms.
- (e) Use of the knowledge of physical properties.
- (f) Heat treatment for various high carbon steels.
- (g) Forging and hardening temperature ranges.
- (h) History and manufacture.
- (i) Use and limitations.
- (j) Allowable impurities SAE and AISI standards.
- (k) Carbon content and form of carbon present.
- (l) Method of machining and fabricating when hard and soft.
- (m) Reasons for use.
- (n) Welding techniques.
- (o) Recognition of symbols for high carbon steel on blueprints.
- (p) Methods of finishing.
- (q) Corrosion prevention.
- (r) Types and features of ground tool steels such as drill rod, ground flat stock, etc.
- (s) Precautions re destroying properties by overheating.
- (t) Methods of showing high carbon steel in cross section on a blueprint.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
<p>1. Selecting, identifying and using manganese steels such as:</p> <p>SAE 1320 SAE 1330 etc.</p>	<p>(a) Methods of testing and identifying manganese steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics of manganese steels e.g. work hardening. (c) Reasons for using manganese steels. (d) The effect of manganese on steel. (e) Uses of manganese steels. (f) Steel terminology and nomenclature. (g) The cost of manganese steel. (h) The manufacture of manganese steel. (i) Limitations of manganese steel. (j) Maximum impurities. (k) Machinability, weldability, etc. (l) Recognition of manganese steel symbols on drawings. (m) The effect of heat treatment. (n) Sources of information e.g. handbook, etc. (o) Method of manufacturing manganese steel. (p) Common forms available. (q) Machining characteristics. (r) Recognition of SAE and AISI numbering systems.</p>
<p>2. Selecting, identifying and using nickel steels, such as:</p> <p>SAE 2317 SAE 2330</p>	<p>(a) Methods of testing and identifying nickel steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics of nickel steels. (c) Reasons for using nickel steels. (d) The effect of heat treating. (e) Maximum impurities. (f) Methods of manufacturing nickel steel. (g) Use and limitations of nickel steel. (h) The cost of nickel steel. (i) Recognition of nickel steel symbols on drawings. (j) Sources of information. (k) Machining characteristics. (l) Machinability, weldability, etc. (m) Terminology and nomenclature. (n) Common forms available. (o) Metals commonly alloyed with nickel and iron. (p) Recognition of SAE and AISI numbering system.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
<p>3. Selecting, identifying and using nickel-chromium steels, such as:</p> <p>SAE 3115 SAE 314C etc.</p>	<p>(a) Methods of testing and identifying nickel-chromium steels as B13, U1, O1, 2 and 3.</p> <p>(b) Types, features and characteristics of nickel-chromium steels.</p> <p>(c) Reason for using.</p> <p>(d) Possible heat treatments.</p> <p>(e) Maximum impurities.</p> <p>(f) Methods of manufacture.</p> <p>(g) The cost of nickel-chromium steels.</p> <p>(h) The use and limitations.</p> <p>(i) Recognition of nickel-chromium drafting symbols.</p> <p>(j) Machining characteristics.</p> <p>(k) Machinability, weldability, etc.</p> <p>(l) Terminology and nomenclature.</p> <p>(m) Common forms.</p> <p>(n) Recognition of SAE and AISI numbering system.</p> <p>(o) Other metals commonly alloyed with chromium, nickel and iron.</p> <p>(p) Sources of information.</p>
<p>4. Selecting, identifying and using molybdenum steels, such as:</p> <p>SAE 4017 SAE 4068 etc.</p>	<p>(a) Methods of testing and identifying molybdenum steels as B13, U1, O1, 2 and 3.</p> <p>(b) Types, features and characteristics of molybdenum steels.</p> <p>(c) Reasons for using.</p> <p>(d) Possible heat treatments.</p> <p>(e) Maximum impurities.</p> <p>(f) Method of manufacture.</p> <p>(g) Cost of molybdenum steels.</p> <p>(h) Use and limitations.</p> <p>(i) Recognition of molybdenum steel drafting symbols.</p> <p>(j) Machinability, weldability, etc.</p> <p>(k) Terminology and nomenclature.</p> <p>(l) Common forms.</p> <p>(m) Recognition of SAE and AISI numbering system.</p> <p>(n) Other metals commonly alloyed with molybdenum and iron.</p> <p>(o) Sources of information.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
5. Selecting, identifying and using chromium-molybdenum steels, such as:	(a) Methods of testing and identifying chromium-molybdenum steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of chromium-molybdenum drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering system. (n) Sources of information.
SAE 4119 SAE 4150	
6. Selecting, identifying and using nickel-chromium-molybdenum steels, such as:	(a) Methods of testing and identifying nickel-chromium-molybdenum steels as B13, U1, O1, 2, 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of nickel-chromium-molybdenum drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.
SAE 4317 SAE 434C	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
7. Selecting, identifying and using nickel-molybdenum steels, such as: SAE 4608 SAE X 4620 SAE 4820 etc.	(a) Methods of identifying and testing nickel-molybdenum steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of nickel-molybdenum drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.
8. Selecting, identifying and using chromium steels, such as: SAE 5045 SAE 5115 SAE 50100 etc.	(a) Methods of testing and identifying chromium steels, as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of chromium drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
9. Selecting, identifying and using chromium-vanadium steels, such as: SAE 6115 SAE 612C etc.	(a) Methods of testing and identifying chromium-vanadium steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of chromium-vanadium drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.
10. Selecting, identifying and using tungsten steels, such as SAE 7136C SAE 7166C	(a) Methods of identifying and testing tungsten steels as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of tungsten drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS

UNIT 3: FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
11. Selecting, identifying and using silicon-manganese steel, such as: SAE 9255 SAE 9260 etc.	(a) Methods of identifying and testing silicon-manganese steel as B13, U1, O1, 2 and 3. (b) Types, features and characteristics. (c) Reasons for using. (d) Cost. (e) Heat treatments. (f) Maximum impurities. (g) Method of manufacture. (h) Use and limitations. (i) Recognition of silicon-manganese drafting symbols. (j) Machinability, weldability, etc. (k) Terminology and nomenclature. (l) Common forms. (m) SAE and AISI numbering systems. (n) Sources of information.

BLOCK X: PROPERTIES AND USES OF MATERIALS

UNIT 4: BASIC NON-FERROUS METALS

OPERATIONS	KNOWLEDGE
1. Selecting, identifying and using lead	(a) Methods of testing and identifying lead as B13, U1, O1, 2 and 3. (b) Uses for lead e.g. sheathing, acid containers, batteries, etc. (c) Characteristics of lead. (d) Melting temperatures. (e) Simple tests for the pouring e.g. pine stick chars, etc. (f) Forms in which it may be purchased e.g. sheet, ingot, etc. (g) Cost of lead. (h) Methods of fabricating. (i) Drafting symbols for lead.
2. Selecting, identifying and using copper	(a) Methods of testing and identifying copper as B13, U1, O1, 2 and 3. (b) Uses for copper e.g. electric wires, roofing, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 4: BASIC NON-FERROUS METALS

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none">(c) Reasons for using e.g. conductivity, corrosion resistance, etc.(d) Heat treatment of copper.(e) Methods of hardening and strengthening e.g. planishing, rolling, lining, etc.(f) Forms in which it may be purchased e.g. sheet, foil, wire, bars, etc.(g) Methods of fabricating e.g. riveting, soldering, etc.(h) Manufacture of sheet copper, wire, etc.(i) Characteristics of copper.(j) Cost of copper.(k) Methods of finishing.(l) Standard drafting symbols for copper.
3. Selecting, identifying and using tin	<ul style="list-style-type: none">(a) Methods of testing and identifying tin as B13, U1, O1, 2 and 3.(b) Uses for tin e.g. plating, alloys, etc.(c) Reasons for using e.g. corrosion resistance, appearance, etc.(d) Surface finish obtainable.(e) Characteristics of tin.(f) Melting temperature of tin.(g) Methods of fusing tin.(h) Cost of tin.
4. Selecting, identifying and using aluminum	<ul style="list-style-type: none">(a) Methods of testing and identifying aluminum as B13, U1, O1, 2 and 3.(b) Uses for aluminum e.g. patterns, castings, bar stock, etc.(c) Melting temperatures.(d) Heat treatment procedures.(e) Reasons for using aluminum e.g. weight, corrosion resistance, etc.(f) Characteristics of aluminum.(g) Manufacture of aluminum.(h) Forms in which it may be purchased e.g. ingot, rod, wire, sheet, etc.(i) History of aluminum.(j) Cost of aluminum.(k) Recognition of standard drafting symbols for aluminum.(l) Methods of finishing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 4: BASIC NON-FERROUS METALS

OPERATIONS	KNOWLEDGE
4. Cont'd.	(m) Machinability, weldability, etc. (n) Methods of using aluminum in alloys e.g. dural, etc.
5. Selecting, identifying and using zinc	(a) Methods of testing and identifying zinc as Bl3, Ul, Ol, 2 and 3. (b) Uses for zinc e.g. galvanizing, killed spirits, etc. (c) Characteristics of zinc. (d) Methods of galvanizing. (e) Manufacture of zinc. (f) Forms in which zinc may be purchased. (g) Cost. (h) Recognition of standard drafting symbols for zinc. (i) Methods of using zinc in alloys e.g. die casting alloys.
6. Selecting, identifying and using antimony	(a) Methods of testing and identifying antimony as Bl3, Ul, Ol and 2. (b) Production of antimony. (c) Uses for antimony e.g. in alloys. (d) Melting temperatures. (e) Characteristics of antimony. (f) Cost of antimony. (g) Reason for using antimony.
7. Selecting, identifying and using bismuth	(a) Methods of testing and identifying bismuth as Bl3, Ul, Ol and 2. (b) Uses for bismuth e.g. in alloys (c) Characteristics of bismuth. (d) Melting temperatures. (e) Cost of bismuth. (f) Reason for using bismuth.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 4: BASIC NON-FERROUS METALS

OPERATIONS	KNOWLEDGE
8. Selecting, identifying and using magnesium	<ul style="list-style-type: none"> (a) Methods of testing and identifying magnesium as B13, U1, O1 and 2. (b) Uses for magnesium e.g. alloys, castings, etc. (c) Characteristics of magnesium. (d) Heat treatment of magnesium. (e) Reasons for using magnesium. (f) Cost of magnesium. (g) Recognition of standard drafting symbols for magnesium. (h) Methods of finishing. (i) Machinability, weldability, etc. (j) Safety practices re danger of fire from cuttings.
9. Selecting, identifying and using silver	<ul style="list-style-type: none"> (a) Methods of testing and identifying silver as B13, U1, O1 and 2. (b) Uses for silver e.g. plating, conductivity, alloys, etc. (c) Characteristics of silver. (d) Methods of plating. (e) Heat treatments - annealing. (f) Cost of silver. (g) Methods of finishing. (h) Melting temperature. (i) Reasons for using silver.

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 5: NON-FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
1. Selecting, identifying and using copper alloys, such as: brasses	<ul style="list-style-type: none"> (a) Methods of testing and identifying brasses as B13, U1, O1, 2 and 3. (b) Types of brasses e.g. cast, wrought, sheet, wire, rod, etc. (c) Uses for brasses e.g. hardware, marine equipment, etc. (d) Characteristics of brasses.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 5: NON-FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
1. Cont'd.	(e) Recognition of symbols for brasses on blueprints. (f) Melting and annealing temperatures. (g) Limitations of brasses. (h) Surface finish obtainable on various types of brasses. (i) The part each alloying metal plays in brasses e.g. free-cutting lead, etc. (j) Methods of fabricating e.g. bolting, crazing, riveting, etc. (k) Costs of various brasses. (l) Safety practices re brass poisoning.
2. Selecting, identifying and using copper alloys such as: commercial bronze phosphor bronze manganese bronze aluminum bronze etc.	(a) Methods of testing and identifying bronzes as B13, U1, O1, 2 and 3. (b) Uses for bronzes e.g. shafting, pump bodies, thrust collars, bearings, etc. (c) Characteristics of bronzes. (d) Surface finish obtainable. (e) Forms in which it is used e.g. castings, shafting, etc. (f) Costs of various bronzes. (g) Recognition of standard drafting symbols for bronze.
3. Selecting, identifying and using aluminum alloys	(a) Methods of testing and identifying aluminum alloys as B13, U1, O1, 2 and 3. (b) Types and features of aluminum alloys e.g. dur-aluminum, aluminum bronze, etc. (c) Uses for aluminum alloys e.g. castings, machine parts, etc. (d) Advantages of aluminum alloys e.g. weight, corrosion resistance, etc. (e) Melting temperatures. (f) Characteristics of each alloy. (g) Costs of aluminum alloys.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 5: NON-FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
4. Selecting, identifying and using babbitt metal	<ul style="list-style-type: none">(a) Methods of testing and identifying babbitt metal as B13, U1, O1, 2 and 3.(b) Uses for babbitt metal e.g. bearings, pads, etc.(c) Characteristics of babbitt metal.(d) Melting temperatures.(e) Composition of babbitt metal for various alloys e.g. SAE standards.(f) Surface finish obtainable.(g) Costs of babbitt metal.(h) Recognition of standard drafting symbols for babbitt.
5. Selecting, identifying and using solders	<ul style="list-style-type: none">(a) Methods of testing and identifying solders as B13, U1, O1, 2 and 3.(b) Types of solder e.g. soft, hard, etc.(c) Characteristics of various solders.(d) Fluxes used with various solders e.g. borax, paste, acids, etc.(e) Forms in which it may be purchased e.g. sheet, wire, bar, cored, etc.(f) Uses for various types of solder e.g. sweating, joining metals, etc.(g) Materials which may be soldered.(h) Melting temperatures.(i) Nomenclature and terminology.(j) Costs of solders, hard and soft.
6. Selecting, identifying and using magnesium alloys	<ul style="list-style-type: none">(a) Methods of testing and identifying magnesium alloys as B13, U1, O1, 2 and 3.(b) Advantages of magnesium alloys e.g. weight, strength, etc.(c) Uses for magnesium alloys e.g. rod castings, etc.(d) Mechanical properties of various alloys.(e) Heat treatment.(f) Recognition of standard drafting symbols.(g) Cost of magnesium alloys.(h) Forms in which magnesium alloys are usually found.(i) Methods of machining and fabricating.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 5: NON-FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
7. Selecting, identifying and using zinc alloys	<ul style="list-style-type: none">(a) Methods of testing and identifying zinc alloys as Bl3, Ul, Ol, 2 and 3.(b) Reasons for using zinc alloys, zinc die castings, etc.(c) Types, features and characteristics of zinc alloys.(d) Machinability, weldability, etc.(e) Melting temperatures.(f) Advantages of zinc alloys.(g) Cost of zinc alloys.(h) Methods of fabricating and machining.(i) Methods of repairing.
8. Selecting, identifying and using stellite and other hard surfacing materials	<ul style="list-style-type: none">(a) Methods of testing and identifying as Bl3, Ul, Ol, 2 and 3.(b) Types, features and characteristics of hard surfacing materials.(c) Types, features and characteristics of stellite tools.(d) Methods of holding stellite tools.(e) Cost of stellite tools.(f) Forms in which stellite may be purchased.(g) Types, features and characteristics of hard surfacing welding rod.(h) Precautions re brittle nature of stellite.(i) Reasons for using hard surfacing materials.(j) Heat treatments recommended for hard surfacing materials.
9. Selecting, identifying and using sintered carbides	<ul style="list-style-type: none">(a) Methods of testing and identifying as Bl3, Ul, Ol, 2 and 3.(b) Types, features and characteristics of sintered carbides e.g. edge tool and percussion type.(c) Methods of mounting carbide tips.(d) Uses of sintered carbide tips.(e) Forms in which carbides are produced.(f) Cost of carbide tips.(g) Methods of manufacturing.(h) Limitations of carbides.(i) Precautions re brittle nature of carbides.(j) Reasons for using carbides.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 5: NON-FERROUS ALLOYS

OPERATIONS	KNOWLEDGE
<p>10. Selecting, identifying and using powdered products, such as:</p> <p>porous bearings electrical contacts etc.</p>	<p>(a) Methods of testing and identifying as B13, U1, O1, 2 and 3.</p> <p>(b) Types, features and characteristics of powdered materials.</p> <p>(c) Uses for powdered materials.</p> <p>(d) Methods of manufacture.</p> <p>(e) Cost of powdered materials.</p> <p>(f) Reasons for using powdered metal and other materials.</p> <p>(g) Reasons for sintering.</p> <p>(h) Methods of sintering.</p> <p>(i) Methods of lubricating porous bearings.</p> <p>(j) Precautions re machining powdered materials e.g. danger of collapse.</p> <p>(k) Methods of sizing after sintering.</p>

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 6: NON-METALLIC MATERIALS

OPERATIONS	KNOWLEDGE
<p>1. Selecting, identifying and using abrasives, such as:</p> <p>diamond emery corundum sand (silica) crushed garnet quartz tripoli pumice silicon carbide aluminum oxide etc.</p>	<p>(a) Methods of testing and identifying abrasives as B13, U1, O1, 2 and 3.</p> <p>(b) Application of the abrasive e.g. grinding, buffing, etc.</p> <p>(c) Methods of classifying grain size.</p> <p>(d) Materials suitable for bonding abrasives.</p> <p>(e) Functions of abrasive materials.</p> <p>(f) Selection of the abrasive material for the job.</p> <p>(g) Manufacturing and refining processes for natural and artificial abrasives.</p> <p>(h) Storing and handling of abrasives.</p> <p>(i) Surface finish obtainable with various abrasives.</p> <p>(j) Forms in which it is purchased e.g. abrasive cloth, bulk, grindstones, etc.</p> <p>(k) Costs of abrasive materials.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 6: NON-METALLIC MATERIALS

OPERATIONS	KNOWLEDGE
2. Selecting, identifying and using plastics	<ul style="list-style-type: none"> (a) Methods of testing and identifying plastics as Bl3, Ul, Ol, 2 and 3. (b) Types and features of plastics. (c) Characteristics and properties of various plastics. (d) Advantages of plastics e.g. weight, cost, etc. (e) Forms in which it may be purchased e.g. rods, tubes, sheets, etc. (f) Nomenclature e.g. phenolic, thermo-setting, etc. (g) Surface finish obtainable. (h) Colours obtainable. (i) Effect of light on some colours. (j) Effect of heat e.g. fading, blistering, etc. (k) Machinability of various plastics.
3. Selecting, identifying and using asbestos and asbestos products	<ul style="list-style-type: none"> (a) Methods of testing and identifying asbestos as Bl3, Ul, Ol, 2 and 3. (b) Forms in which it may be purchased e.g. sheet, powder, etc. (c) Uses for asbestos e.g. babbitt putty, filters, etc. (d) Characteristics and properties of asbestos. (e) Production of asbestos. (f) Costs of asbestos and asbestos products.
4. Selecting, identifying and using cloth and cloth products	<ul style="list-style-type: none"> (a) Methods of identifying cloth and cloth products as Bl3, Ul, Ol and 2. (b) Uses for cloth e.g. felt wicks, buffing and polishing, wiping, etc. (c) Methods of cutting cloth and felt. (d) Characteristics and uses of cloth for various jobs. (e) Safety precautions re storing oily rags.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 6: NON-METALLIC MATERIALS

OPERATIONS	KNOWLEDGE
5. Selecting, identifying and using cutting oils	<ul style="list-style-type: none"> (a) Methods of testing and identifying cutting oils as Bl3, Ul, Ol and 2. (b) Types of various cutting oils e.g. lard oil, sulphur oil, soluble, etc. (c) Characteristics of various types of cutting oil. (d) Common trade names. (e) Methods of preparing soluble oils. (f) Precaution re keeping cutting oils separate from lubricating oils. (g) Safety practices - hazard -- oil on floors slipping, methods of removal. (h) Selecting the cutting oil for the job. (i) Methods of dispensing e.g. oil cans, brush, pump systems, etc. (j) Methods of reclaiming. (k) Cost of various cutting oils. (l) Safety practices - hygiene re skin infections.
6. Selecting, identifying and using lubricating oils	<ul style="list-style-type: none"> (a) Methods of testing and identifying lubricating oils as Bl3, Ul, Ol, 2 and 3. (b) Selection of the correct lubricating oil e.g. charts, literature, etc. (c) Safety precautions - care and storage of lubricating oil, fire hazard. (d) Methods of dispensing e.g. oil cans, wicks, drip feeds, circulating systems, etc. (e) Principles of lubrication. (f) Safety practices re oil on floors, slipping. (g) Methods of removing oil from floors.
7. Selecting, identifying and using greases	<ul style="list-style-type: none"> (a) Methods of testing and identifying greases as Bl3, Ul, Ol, 2 and 3. (b) Methods of selecting the correct grease for the job e.g. charts, literature, etc. (c) Methods of dispensing grease e.g. grease guns, grease cups, etc. (d) Care and storage of grease. (e) Types and features of grease guns. (f) Safety practices re grease on floors, slipping. (g) Methods of neutralizing or removing grease from floors. (h) Cost of Greases.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 6: NON-METALLIC MATERIALS

OPERATIONS	KNOWLEDGE
8. Selecting, identifying and using rubber and rubber products	<ul style="list-style-type: none"> (a) Methods of testing and identifying rubber as B13, U1, O1, 2 and 3. (b) Uses for rubber e.g. gaskets, bearings, shock absorbers, etc. (c) Methods of cutting rubber e.g. punching, shearing, etc. (d) Reasons for deterioration of rubber e.g. oil, heat, etc. (e) Forms in which it may be purchased e.g. tubes, sheet, string, etc. (f) Types of rubber which may be purchased e.g. soft, hard, etc. (g) Cost of rubber and rubber products.
9. Selecting, identifying and using paper and paper products	<ul style="list-style-type: none"> (a) Methods of testing and identifying paper as B13, U1, O1 and 2. (b) Uses for paper e.g. friction drives, packing, etc. (c) Reasons for using paper. (d) Size of paper obtainable e.g. size of sheets, thickness, etc. (e) Safety precautions re care and storage of paper - fire hazard. (f) Cost of paper and paper products. (g) Safety practices re handling paper - cuts on sharp edges.
10. Selecting, identifying and using fibre and fibre products	<ul style="list-style-type: none"> (a) Methods of testing and identifying fibre as B13, U1, O1 and 2. (b) Classes of fibre e.g. wood fibre, horn fibre, asbestos fibre, etc. (c) Uses for fibre e.g. friction drives, insulators, packing, etc. (d) Forms in which it may be purchased e.g. sheet, tubes, etc. (e) Procedures for cutting, bending, punching, etc. (f) Cost of fibre and fibre products. (g) Safety practices re cuts from sharp edges.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 6: NON-METALLIC MATERIALS

OPERATIONS	KNOWLEDGE
11. Selecting, identifying and using leather and leather products	<ul style="list-style-type: none"> (a) Methods of testing and identifying leather as Bl3, Ul, Ol, 2 and 3. (b) Uses for leather e.g. belting, soft hammers, thongs, etc. (c) Forms in which it may be purchased e.g. sheets, belting, etc. (d) Effect of humidity on leather. (e) Methods of removing oil from leather. (f) Methods of joining leather. (g) Costs of leather and leather products. (h) Care and storage of leather. (i) Methods of cleaning.
12. Selecting, identifying and using woods, as: hickory oak birch fir iron wood beech lignum vitae etc.	<ul style="list-style-type: none"> (a) Methods of testing and identifying wood as Bl3, Ul, Ol, 2 and 3. (b) Selection of the wood for the job e.g. lignum vitae - bearings; hickory - tool handles, fir - skids, oak - friction drives, etc. (c) Reasons for selection. (d) Cost of various woods. (e) Limitations of wood. (f) Calculation of board feet. (g) Handling and storage of wood. (h) Nomenclature and terminology pertaining to wood e.g. quarter cut, end grain, etc. (i) Strength of various woods. (j) Methods of preventing wood deterioration. (k) Machinability. (l) Methods of fabrication.
13. Selecting, identifying and using carbon in its various forms, such as: carbon - amorphous graphite diamond	<ul style="list-style-type: none"> (a) Methods of testing and identifying carbon and carbon products as Bl3, Ul, Ol, 2 and 3. (b) Types and uses of carbon electrodes, crucibles, brushes, etc. (c) Properties of carbon in all its allotropic forms. (d) Common forms in which carbon is produced. (e) Cost of carbon in its various forms.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 7: CHEMICALS

OPERATIONS	KNOWLEDGE
1. Selecting and using acids, such as: hydrochloric muriatic sulphuric nitric phosphoric hydrofluoric etc.	(a) Safety practices: (a) proper procedures for handling acids, (b) care of clothing, hands and eyes, (c) proper antidotes. (b) Methods of identifying acids. (c) Characteristics of acids. (d) Uses of acids in machine shop practice. (e) Features and functions of equipment for storage, transportation and use of acids. (f) Cost of various acids. (g) Methods of neutralizing.
2. Selecting and using common salts, such as: sal ammoniac ammonium chloride tin chloride zinc chloride calcium oxide common lime calcium chloride potassium nitrate etc.	(a) Safety practices: (a) proper procedures for handling salts, (b) care of clothing, hands, eyes, (c) proper antidotes. (b) Methods of identifying these salts. (c) Characteristics of these salts. (d) Uses of these salts in machine shop practice. (e) Features and functions of equipment used in storage, transportation and use of salts. (f) Cost of various salts. (g) Methods of removal or neutralization.
3. Selecting and using carburizing and heating-salt bath cyanides, etc. such as: various commercial mixtures high temperature salt mixtures tempering salt mixtures etc.	(a) Safety practices: (a) proper procedures for handling salts, (b) care of clothing, hands and eyes, (c) first aid for burns, (d) proper antidotes. (b) Methods of identifying salts. (c) Characteristics of salts. (d) Uses of these salts in machine shop practice. (e) Features and functions of equipment used in storage, transportation and use of salts. (f) Cost of salts and rate of deterioration. (g) Methods of removal or neutralization.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 7: CHEMICALS

OPERATIONS	KNOWLEDGE
4. Selecting and using carburizing, nitriding and protective inert gases, such as: carbon monoxide from (a) coal gas (b) from incomplete combustion of coke (c) acetylene (d) natural gas (e) other organic compounds ammonia argon, etc.	(a) Safety practices: (a) effects from exposure to these gases, (b) proper preventative procedures to prevent asphyxiation or explosion. (b) Methods of identifying these gases. (c) Tests for suitable heating atmospheres. (d) Characteristics of gases. (e) Uses of gases in machine shop practice. (f) Features and functions of equipment employed to transport, store or use gases. (g) Cost of gases.
5. Selecting and using various solvents, such as: petroleum solvent carbon tetrachloride diesel fuel oil etc.	(a) Safety practices: (a) care of hands, clothing and eyes, (b) proper first aid practices. (b) Methods of identifying of liquids. (c) Characteristics of liquids. (d) Uses of these liquids in machine shop practice. (e) Features and functions of equipment used in transporting, storing and using liquids. (f) Cost of these liquids. (g) Methods of removing these liquids.
6. Selecting and using various petroleum base lubricants, hydraulic line fluids, graphite white or red lead oxides, etc.	(a) Safety practices: (a) care of clothing, hands and eyes. (b) Methods of identifying these substances. (c) Characteristics of these substances. (d) Use of these substances in machine shop practice. (e) Features and functions of equipment used to store, transport and use these substances. (f) Cost of these materials.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK X: PROPERTIES AND USES OF MATERIALS UNIT 7: CHEMICALS

OPERATIONS	KNOWLEDGE
7. Selecting and using various refractory materials, such as: firebrick, silica brick, asbestos insulating brick, sands, clays and mortars, graphite brick, porcelain, etc.	(a) Methods of identifying of refractories. (b) Characteristics of refractories. (c) Standard brick sizes and shapes. (d) Uses of refractories in machine shop practice. (e) Cost of various refractories. (f) Methods of mixing and using powdered refractories. (g) Methods of building up refractory ovens, furnaces, etc. (h) Degree of heat each refractory will stand. (i) Use of graphite as electrode, etc.
8. Selecting and using various fuels, such as: blacksmith's coal, coke, petroleum coke - carbon, manufactured gas, natural gas, fuel oils, charcoal - etc.	(a) Safety practices: (a) prevention of explosions and treatment of burns. (b) Methods of identifying fuels. (c) Characteristics of these fuels. (d) Uses of these fuels in machine shop practice. (e) Features and functions of equipment used in storing, transporting and using these fuels. (f) Comparative cost of fuels. (g) Comparative rate at which each fuel may be burned - number of B.T.V.'s per hour, flame temperatures, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI - TURRET LATHE PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine	298
Unit 2. Work Holding Techniques	301
Unit 3. Tooling Techniques	307
Unit 4. Miscellaneous Techniques	313

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRETT LATHE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine.	<ul style="list-style-type: none"> (a) Names and functions of machine parts. (b) Kinds, uses and selection of lubricants. (c) Lubrication methods and procedures. (d) Types and features of lubricating equipment e.g. centralized; pressure; etc. (e) Statistical control of lubrication, etc. e.g. schedule, charts; etc. (f) Diagnosis and correction of lubrication troubles e.g. traceable to lubricants; traceable to method of application; traceable to mechanical condition. (g) Precautions re over-filling geared heads.
2. Controlling the machine.	<ul style="list-style-type: none"> (a) Features and functions of primary controls e.g. power, clutch, etc. (b) Features and functions of head stock control mechanisms. (c) Features and functions of rapid traverse controls. (d) Types and features of feed trips and stops. (e) Types and features of coolant system controls. (f) Precautions re hand operation before applying power. (g) Precautions re reading manual and instruction cards.
3. Adjusting the machine.	<ul style="list-style-type: none"> (a) Responsibilities of the operator e.g. clean; lubricate; level; adjust, etc. (b) Methods of adjusting moving parts e.g. tightness required in gibs. (c) Methods of compensating for wear. (d) Procedures and equipment for testing the machine. (e) Types, features and functions of tools and instruments used. (f) Methods of testing and adjusting clutch drag. (g) Methods of servicing lock bolts. (h) Methods of testing and adjusting turret clamps. (i) Methods of adjusting tool stands and feed mechanism.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (j) Methods of adjusting safety devices. (k) Need for periodic rechecks. (l) Types, features and functions of turret stops. (m) Types, features and functions of carriage stops. (n) Methods of setting and locking stops. (o) Precautions re over-tightening gibs. (p) Precautions re disturbing bed-pan-leg bolt setting e.g. factory set.
4. Handling and mounting work holding device as:	<ul style="list-style-type: none"> (a) Types and features of standard spindle noses. (b) Methods of handling and mounting accessories. (c) Types and features of turret lathe accessories. (d) Care, maintenance and storage of accessories. (e) Types and features of tool stands. (f) Types and features of hoisting equipment. (g) Types and features of accessory adapters. (h) Types and features of chuck jaws e.g. standard, floating, soft, etc. (i) Methods of mounting chuck jaws. (j) Types and features of turret lathe chucks. (k) Types and features of chuck tightening devices e.g. hydraulic, air, etc. (l) Methods of adjusting jaw pressure. (m) Types and features of power chuck controls. (n) Types and features of faceplate jaws. (o) Types, features and uses of chuck jacks. (p) Methods of centering and aligning work e.g. stops, spacers, spigots, etc. (q) Methods of mounting centering pilots. (r) Types and uses of spoke-clamps. (s) Types and features of splash guards. (t) Care of machine while mounting accessories. (u) Methods of handling accessories for mounting e.g. turret carriers. (v) Types and features of turret lathe centers. (w) Types, features and applications of turret lathe steady rests.
chucking chucks (2,3,4,6 jaw and special. faceplates, centers, steady rest.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (x) Methods of adjusting steady rests. (y) Precautions re cleaning and inspecting mating parts e.g. spindles, etc. (z) Precautions re spotting chuck e.g. for air wrenches. (aa) Precautions re de-burring locating surfaces. (ab) Safety practices handling.
5. Handling and mounting work-holding device as: bar work accessories: collets, stock supports, feed mechanism.	<ul style="list-style-type: none"> (a) Types, features and functions of collets. (b) Types, features and functions of collet pads and adapters. (c) Types, features and functions of bar stock feed mechanisms. (d) Types, features and functions of bar stock spindle supports e.g. external and internal. (e) Types and features of stock supports. (f) Types and features of feed fingers. (g) Methods of adjusting feed fingers mechanism. (h) Types, features and functions of power and hand operated collet controls. (i) Types, features and functions of power and hand operated feed controls. (j) Methods of aligning and adjusting stock supports. (k) Care, maintenance, and storage of bar work accessories. (l) Types and features of automatic bar feeds e.g. spindle roller type; weighted, etc. (m) Methods of adjusting collet tension. (n) Accuracy and limitations of bar work accessories. (o) Precautions re cleaning and inspecting accessories before assembling.
6. Handling and mounting tool-holding accessories as: facing heads turning heads (e.g. roller turner) drill holders, boring head adapters,	<ul style="list-style-type: none"> (a) Types and features of standard turret faces. (b) Methods of handling and attaching turret accessories. (c) Methods of handling and attaching cross slide accessories. (d) Types and features of turret lathe cross slides. (e) Types and features of turret-face adapters.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
6. Cont'd. reamer holders, forming heads and tool holders, die heads, tap holders, threading tool holders, knurling heads, knurling tool holders, compound slides, square turrets, stock stops.	(f) Types and features of cross slide raising blocks. (g) Principles of tooling. (h) Care, storage and maintenance of accessories. (i) Methods of adjusting accessories. (j) Methods of cleaning and inspecting accessories. (k) Types and features of locking devices e.g. set screws, clamps, etc. (l) Types and features of coolant line fastenings. (m) Types and features of tooling cards. (n) Precautions re over-tightening set screws. (o) Precautions re cleaning spigots. (p) Precautions re using cup point set screws.

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work.	(a) Features and uses of the available turret lathe. (b) The scope of Ram Type Turret Lathes. (c) The scope of Saddle Type Turret Lathes. (d) Accuracy required on the work. (e) The rigidity required in the setup. (f) Simplicity of setup e.g. setup time factor. (g) The quantity of parts to be made. (h) Features and uses of standard work holding equipment. (i) Types and features of standard attachments e.g. special jaws, fixtures, etc. (j) Types of jigs and fixtures for odd shaped work. (k) Shape and weight of work pieces.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>2. Setting up work in a collet such as:</p>	<ul style="list-style-type: none"> (a) Types, features, functions and limitations of collets. (b) Methods of mounting master bushings. (c) Standard bushing shapes e.g. round, hexagon, square, etc. (d) Methods of preventing back-slippage e.g. serrated jaws. (e) Methods of adjusting collets. (f) Range of adjustment. (g) Types of spring collets. (h) Methods of adjusting spring collets. (i) The accuracy of collets for second operation work. (j) The advantages of stationary type collets e.g. for endwise location. (k) The care and storage of solid collets. (l) Types and features of master collets and bushings. (m) Methods of attaching bushings. (n) Types and features of back stops. (o) Types and features of power operated collets e.g. air, Hydraulic, Electric. (p) Features and functions of skeleton chucks. (q) Methods of feeding bar stock. (r) Types and features of feed mechanisms. (s) Methods of supporting bar stock. (t) Methods of adjusting bar feed. (u) Methods of handling bar stock. (v) Methods of cleaning bar stock. (w) Precautions re over-tightening retaining screws. (x) Precautions re straightness of bar stock. (y) Precautions re cleaning parts.
<p>3. Setting up work on an arbor, such as:</p>	<ul style="list-style-type: none"> (a) Types, features and uses of work arbors, male and female. (b) Methods of mounting arbors. (c) Types and features of arbor adapters e.g. plain, adjustable. (d) Types and features of power operated arbors. (e) The accuracy of various arbors. (f) Preparation of work for arbor work. (g) Methods of preventing work winding under cut pressure e.g. locking devices. (h) Methods of mounting work on solid arbors.

parallel closing,
spring type,
stationary type,
master type,
extra capacity,
stepped type.

solid type,
expanding bushing
type,
expanding plug type,
threaded arbors.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (i) Methods of removing work from solid arbors. (j) Methods of truing-up faceplate arbors. (k) Types, features and care of indicating equipment. (l) Methods of driving large diameter work. (m) Lubricants required. (n) Types and applications of keys and keyways. (o) Methods of loading and unloading work on threaded arbors. (p) Precautions re work jamming e.g. on power arbors. (q) Precautions re jamming air cylinder. (r) Precautions re over-expanding plug type arbors. (s) Precautions re cross-threading work on threaded arbors.
4. Setting up work in a chuck, such as:	<ul style="list-style-type: none"> (a) Requirements of the setup e.g. rigidity accuracy, speed, etc. (b) Methods of handling and mounting chucks. (c) Types and features of standard chucks, e.g. hand operated, power operated, wrenchless. (d) Methods of holding small irregular shaped work e.g. box chucks. (e) Types and features of box chuck jaws. (f) Methods of holding multiple facework e.g. revolving jaw chucks. (g) Limitations of standard chucks. (h) Methods of using reversible tap jaws. (i) Applications and advantages of wrenchless chucks. (j) Methods of adjusting gripping pressure. (k) Pressure required for air chucks. (l) Methods of locking air chuck jaws e.g. to offset centrifugal force. (m) Methods of checking truth of chuck mounting. (n) Types and features of chuck locking shoes and drive pins. (o) Methods of mounting chuck jaws. (p) Types and features of first operation jaws. (q) Types and features of work back stops. (r) Methods of hard surfacing chuck jaws. (s) Types and features of jaw serrulations. (t) Types and features of second operation jaws.
Universal (2, 3, 4, and 6 jaw), Independent (4 jaw), Combination (3 or 4 jaw), Wrenchless.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS

KNOWLEDGE

4. Cont'd.

- (u) Materials used for soft jaws.
- (v) Methods of machining soft jaws.
- (w) Methods of maintaining chuck accuracy.
- (x) Types and features of locating plugs.
- (y) Methods of floating universal chuck scroll.
- (z) Types and features of rocking jaws.
- (aa) Types and features of power operated compensating jaw chucks.
- (ab) Methods of holding long work.
- (ac) Types and features of holding clamps.
- (ad) Types, features and applications of centering bells.
- (ae) Preparation of work for chucking e.g. chucking rim; recess; etc.
- (af) Methods of holding frail work.
- (ag) Types and features of jaws for pinching frail work.
- (ah) Types and features of extra capacity jaws.
- (ai) Methods of holding rectangular work in a 3 jaw chuck.
- (aj) Principles of preliminary chucking.
- (ak) Methods of loading work.
- (al) Types, features and applications of centering plugs e.g. internal and external.
- (am) Types, features and applications of chucking fixtures.
- (an) Methods of supporting heavy bar stock.
- (ao) Types and features of internal stock supports.
- (ap) Methods of feeding heavy bars through spindle.
- (aq) Methods of adjusting power chuck jaws for minor work discrepancies.
- (ar) Precautions re uniform work size for wrenchless chucks.
- (as) Precautions re over speeding wrenchless chucks.
- (at) Precautions re marking tightening pinion e.g. on universal chucks.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>5. Setting up work on a faceplate, such as:</p> <p>plain type, slotted type, special.</p>	<p>(a) Types, features and applications of standard faceplates.</p> <p>(b) Type of work requiring a faceplate setup.</p> <p>(c) Methods of mounting work on faceplates.</p> <p>(d) Types and features of locating spigots and pilots.</p> <p>(e) Preparation of production work for faceplate work e.g. jig-drilled, etc.</p> <p>(f) Types and features of quick-acting clamps.</p> <p>(g) Methods of counterbalancing off-center work, Mechanics.</p> <p>(h) Methods of preventing work slippage.</p> <p>(i) Methods of supporting work while mounting.</p> <p>(j) Methods of adjusting carriage stop roll.</p> <p>(k) Types and features of auxiliary jaws.</p> <p>(l) Methods of truing up small lot work.</p> <p>(m) Types, features and applications of indicating equipment.</p> <p>(n) Types, features and applications of angle plates.</p> <p>(o) Methods of supporting work for loading.</p>
<p>6. Setting up work in special fixtures, such as:</p> <p>standard chuck mounted, faceplate mounted, spindle nose mounted.</p>	<p>(a) Preparation of work for fixture mounting e.g. register points, locating surfaces, etc.</p> <p>(b) The requirements of turret lathe jigs and fixtures.</p> <p>(c) Methods of mounting jigs and fixtures.</p> <p>(d) Methods of holding work for heavy cuts e.g. pot fixtures.</p> <p>(e) Features and uses of angle fixtures.</p> <p>(f) Features and applications of rotating indexing fixtures.</p> <p>(g) The application of power gripping devices to fixtures e.g. high production.</p> <p>(h) Methods of machining in several positions e.g. on different center lines.</p> <p>(i) Types and features of taper lock bolts.</p> <p>(j) Factors governing the use of special fixture e.g. cost, etc.</p> <p>(k) Types and features of splash guards.</p> <p>(l) Methods of applying coolants to fixture work e.g. local application.</p> <p>(m) Types of work requiring piloted tools.</p> <p>(n) Methods of using pilots.</p> <p>(o) Methods of adjusting pilots.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd.	<p>(p) Types and features of pilot bushings.</p> <p>(q) Methods of mounting pilot bushings.</p> <p>(r) Precautions re cleaning of fixture between loadings.</p> <p>(s) Precautions re plugging spindle e.g. coolant loss.</p>
<p>7. Setting up work on centers, such as:</p> <p>solid (male and female), revolving, roller end supports.</p>	<p>(a) Types and features of turret lathe centers.</p> <p>(b) Methods of driving center-mounted work.</p> <p>(c) Types and features of driving plates and dogs e.g. anchored type.</p> <p>(d) Preparation of work for center mounting.</p> <p>(e) Types and features of adjustable live centers.</p> <p>(f) Methods of truing centers.</p> <p>(g) Methods of locking ram or turret carriage.</p> <p>(h) Methods of applying coolants.</p> <p>(i) Methods of lubricating centers.</p> <p>(j) Types and features of center lubricants.</p> <p>(k) Types and features of roller end-supports.</p> <p>(l) Methods of adjusting Turret alignment.</p> <p>(m) Types and features of center spiders and bridges.</p> <p>(n) Precautions re cleaning center holes.</p>
<p>8. Setting up work in a steady rest, such as:</p> <p>plain type, self centering, heavy duty.</p>	<p>(a) Types of turret lathe work requiring a steady rest e.g. cylinders, conrods, tubes, etc.</p> <p>(b) Reasons for using a turret lathe for steady-rest work e.g. heavier cuts, quantity, etc.</p> <p>(c) Types, features and applications of turret lathe steady rests.</p> <p>(d) Methods of mounting steady rests.</p> <p>(e) Methods of loading steady rests.</p> <p>(f) Methods of applying overhead pilots to steady rest setups.</p> <p>(g) Methods of driving steady rest work.</p> <p>(h) Methods of lubricating steady rests.</p> <p>(i) Methods of counterbalancing steady rests.</p> <p>(j) Types and features of steady rest jaws.</p> <p>(k) Methods of adjusting steady rests.</p> <p>(l) Types, features and uses of setup pieces.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
9. Setting up work on the Turret face.	<ul style="list-style-type: none"> (a) Types, features and specifications of standard Turret faces. (b) Methods of attaching jigs and fixtures to the turret face. (c) High production techniques e.g. use of multiple jigs, loading cycle, etc. (d) Types of work machined on turret mountings. (e) Methods of truing up old-lot work. (f) Methods of mounting chucks. (g) Types and features of piloted boring bars.

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Planning the setup	<ul style="list-style-type: none"> (a) Blueprint reading e.g. job specifications. (b) Methods of analysing the job for type of tooling e.g. bar work chuck work. (c) Procedures for analysing the basic machining operations as external, internal. (d) Techniques of laying out tooling diagrams. (e) Types and features of tool tracings. (f) Selecting the method of work-holding. (g) Determine multiple and combined cuts. (h) Sequence of operations e.g. internal cuts first, etc. (i) Economic factors e.g. lot size, possibility of repeat orders, etc. (j) Tooling principles e.g. permanent setups, standard tools, etc. (k) Range of machine feeds and speeds. (l) Methods of determining speeds and feeds for group cuts. (m) Principles and techniques of Time Study. (n) Methods of using Past Performance Data. (o) Types, features and applications of charts and graphs for Unit Time Elements. (p) Methods of reducing setup time. (q) Methods of work handling. (r) Methods of reducing machine handling and cutting time. (s) Methods of taking Hexagon Turret and cross slide multiple cuts.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (t) Methods of tooling for combined cuts. (u) Methods of rigid tool setting e.g. Thrust Blocks, three point contact, etc.
2. Setting up a roller type bar turner, as: single cutter, multiple cutter.	<ul style="list-style-type: none"> (a) Handling and mounting the roller turner as B2, U1, O9. (b) Preparation of setup piece e.g. single point turn .001 undersize. (c) Methods of determining cutter position e.g. gauge, shine mark, etc. (d) Methods of setting and adjusting cutter. (e) Types, uses and care of feeler gauges. (f) Methods of setting and adjusting rollers. (g) Methods of testing roll pressure. (h) Procedures in Trial Running. (i) Check points for oversize and undersize work. (j) Check points for rough or varying diameters. (k) Diagnosis and correction of turning troubles as Starting Lumps, Chatter Marks, Finding Rollers, etc. (l) Methods of chip control. (m) Methods of checking roll-taper. (n) Methods of introducing coolant. (o) Methods of setting and adjusting multiple tools.
3. Setting up a combination end facer and turner	<ul style="list-style-type: none"> (a) Handling and mounting the roller type facer as B2, U1, O9. (b) Types and features of cutting tools. (c) Methods of positioning the cutter. (d) Methods of adjusting rollers. (e) Techniques of setting stops. (f) Procedures for lateral positioning of facing head e.g. in Ram Type Turrets. (g) Methods of removing broken set screws. (h) Methods of using Dial Indicator for tool re-setting. (i) Precautions re true-running work. (j) Precautions re overlightening Binding Screws e.g. mushroomed points.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Setting and adjusting a stock stop, as:</p> <p>solid (male or female), combination stop and starting drill, combination stop and center, revolving face type.</p>	<p>(a) Handling and mounting stock stops as B2, U1, O9.</p> <p>(b) Types and features of flanged tool holders e.g. long, short.</p> <p>(c) Factors governing the selection of stock stop e.g. type of work, condition.</p> <p>(d) Necessity of lubricating sliding member.</p> <p>(e) Procedures in setting stops.</p> <p>(f) Precautions re position in setup e.g. avoid Back Indexing.</p>
<p>5. Setting and adjusting single point cross slide tools as:</p> <p>facing tools, turning tools, necking and cut-off (ganged or single).</p>	<p>(a) Handling and mounting tool holders as B2, U1, O9.</p> <p>(b) Methods of setting tools in square turret tool posts.</p> <p>(c) Types of tool adjustments e.g. parallel mounted, rocking, etc.</p> <p>(d) Types of set screw points suitable for tool setting e.g. avoid cup points.</p> <p>(e) Types and features of rear mounted tool holders e.g. cut-off; gang, etc.</p> <p>(f) Methods of setting carriage travel stop.</p> <p>(g) Amount of overtravel after knock-off.</p> <p>(h) Methods of spacing and adjusting ganged tools.</p> <p>(i) Types and features of gang-tool blocks.</p> <p>(j) Care and storage of permanent gang tool blocks.</p> <p>(k) Methods of setting tools to set-up pieces i.e. work model.</p> <p>(l) Types and features of gauges for setting relative i.e. front-rear tool setting.</p> <p>(m) Design and application of cutting tool.</p> <p>(n) Methods of grinding tools and cutters.</p> <p>(o) Precautions re Blocking Stations.</p>
<p>6. Setting and adjusting center drilling tools, as:</p> <p>hand operated; roller type; solid or chuck mounted.</p>	<p>(a) Handling and mounting center drilling attachments as B2, U1, O9.</p> <p>(b) Types of combination drill and counter-sinks e.g. plain, shouldered, etc.</p> <p>(c) Types and features of adjustable flanged tool holders.</p> <p>(d) Methods of setting drill in alignment.</p> <p>(e) Selection of correct cutting speed.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd.	<ul style="list-style-type: none"> (f) Methods of introducing cutting compounds. (g) Methods of controlling depth of hole. (h) Methods of grinding drills.
7. Setting up Universal Bar Tooling.	<ul style="list-style-type: none"> (a) The placement of tools for large and small quantity lots. (b) Placing tools for minimum machine handling e.g. Skip Index. (c) Classification of Bar work e.g. representative groups, etc. (d) Establishing sequence of tool action e.g. combined cuts. (e) Familiarity with standard equipment for Permanent tooling. (f) Methods of obtaining concentricity. (g) Procedures for setting and adjusting: adjustable Knee Tools; Self-opening Die Heads; Clutch Tap and Die Holders; Drill chucks and Holders; Reversible, Straight, angle holders. (h) Sequence of Internal Operations. (i) Sequence of External Operations. (j) Precautions re numbering sequence on Tooling card.
8. Setting and adjusting drills, as: straight flute drills, twist drills, oil hole and oil tube drills, core drills, flat spade drills, gun drills, multi-diameter drills, tipped drills, etc.	<ul style="list-style-type: none"> (a) Fundamentals of drilling e.g. Hogging out, Truing-up, Sizing. (b) Types, features and applications of drill shanks. (c) Methods of mounting and driving straight-shank drills. (d) Methods of mounting and driving taper-shank drills. (e) Types, features and applications of drill adapters. (f) Factors governing drill selection i.e. material of work, depth of hole, quality of hole, efficiency of coolant, machine conditions, etc. (g) Types and uses of drill charts e.g. Fractional, Letter, Number, Metric. (h) Methods of chip control and disposal. (i) Drill grinding techniques.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
8. Cont'd.	<ul style="list-style-type: none"> (j) Methods of positioning drill in setup. (k) Methods of combining cuts with the drilling operation. (l) Factors governing the speed and feed selection e.g. work material, size of hole, type of combined operation, etc. (m) Methods of setting and adjusting stops. (n) The amount of over-travel from knock-off to dead stop. (o) Methods of recording setup data. (p) Types, features and applications of flanged tool holders. (q) Types, features and applications of turning heads e.g. solid type, adjustable, etc.
9. Setting and adjusting turning heads, as: solid type, adjustable type, multiple cutter holders, offset type, vertical slide tool, horizontal slide tool, etc.	<ul style="list-style-type: none"> (a) Handling and mounting turning heads as B2, U1, O9. (b) Types and features of cutting tools used. (c) Methods of setting and positioning cutting tools. (d) Types and features of pilot bars e.g. overhead stationary, overhead revolving, central piloting. (e) Methods of setting and adjusting pilot bars. (f) Advantages of graduated pilot bars. (g) Types, features and applications of pilot bushings e.g. solid, revolving. (h) Types, features and applications of cutter setting gauges. (i) Methods of lubricating pilots. (j) Allowances for finish cuts. (k) Methods of balancing cutting torque e.g. tandem cutters, etc. (l) Procedures re stop-roll setting. (m) Feeds and speeds for multiple cutting e.g. external cuts, internal cuts, combined cuts. (n) Methods of setting cutter holders, as: reversible straight, angle cutter holders, adjustable cutter holders. (o) Procedures in pre-run checking. (p) Types, features, applications, and care of measuring instruments e.g. calipers and scales, micrometers, vernier calipers, etc. (q) The effect of tool position on cutting action.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>10. Setting and adjusting boring tools, as:</p> <p> stub boring bars, fixed center bars, floating cutter</p>	<p>(a) Handling and mounting boring equipment as B2, U1, O9.</p> <p>(b) Types and features of boring tools e.g. material of cutter, design and application, etc.</p> <p>(c) Methods of adjusting cutters.</p> <p>(d) Types, features and application of Indicators, cutter-setting gauges, etc.</p> <p>(e) Allowances for finish boring and reaming.</p> <p>(f) Methods of measuring bores.</p> <p>(g) Types, features, applications and care of hole-measuring instruments e.g. calipers and steel rule, telescope gauges, inside micrometers, indicating gauges, etc.</p> <p>(h) Methods of testing machine alignment.</p> <p>(i) Quality of bore expected from various boring methods.</p> <p>(j) Types, features and applications of boring-bar attachments e.g. chamfering heads, counterboring heads, multi-cutter heads, etc.</p> <p>(k) Factors controlling feeds and speeds for boring.</p> <p>(l) Principles of combined and multiple cutting.</p> <p>(m) Features and functions of splash hoods and guards.</p> <p>(n) Methods of introducing coolant in boring operations.</p> <p>(o) The Geometry of cutting tool positions e.g. vertical, horizontal, etc.</p> <p>(p) Types and features of expansion cutters.</p> <p>(q) Methods of using piloted bars in Ram Type Turrets.</p>
<p>11. Setting up Universal chucking tooling.</p>	<p>(a) Principles of a permanent chucking setup.</p> <p>(b) Methods of providing flexibility in a permanent setup.</p> <p>(c) Methods of determining length in small-lot work.</p> <p>(d) Types, features and applications of measuring tools and gauges for small lots.</p> <p>(e) Multiple cuts for medium lot work e.g. one pass turning and boring from Hexagon turret.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 3: TOOLING TECHNIQUES

OPERATIONS	KNOWLEDGE
11. Cont'd.	<ul style="list-style-type: none"> (f) The importance of rigidity in chucking work e.g. tool overhang. (g) The use of micrometer dials on Universal tools e.g. compensate for tool wear, establish size, etc. (h) Methods of avoiding work spring, in thin walled work e.g. opposed turning and boring tool mounting. (i) Techniques of production planning. (j) Types, features and applications of special turning heads. (k) Types and features of integral cutter blocks. (l) Methods of grouping turret lathe jobs e.g. bar work by diameter, chucking work by the bore.
12. Tooling up for Tool room work.	<ul style="list-style-type: none"> (a) The type of tool room work suitable for the Turret Lathe. (b) Methods of adapting full length Independent Lead Screws. (c) The advisability of using Shank-type tools. (d) Types of standard turret tools for minimum tool room requirements. (e) Methods of using open type square turrets. (f) Techniques of cross slide multiple cuts. (g) Techniques of hexagon turret multiple cuts.

BLOCK XI: TURRET LATHE PRACTICE

UNIT 4: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Machining small, short parts, in quantity lots such as: rollers, pins, etc. Work held: in a collet.	<ul style="list-style-type: none"> (a) Methods of magazine and chute loading. (b) Types, features and methods of mounting filler tubes. (c) Types, features and methods of mounting push-rods and plungers. (d) Types and features of revolving-face stock stops. (e) Turret lathe machining techniques. (f) High production techniques.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XI: TURRET LATHE PRACTICE

UNIT 4: MISCELLANEOUS TECHNIQUES

OPERATIONS

KNOWLEDGE

2. Tapping small parts in quantity lots, such as: nuts, flanges, etc.

Work held:

on the Turret face,
on the cross slide.

- (a) Types, features and applications of extension-shank taps.
- (b) Methods of live-mounting taps.
- (c) Types and features of Hexagon Turret-mounted fixtures e.g. loaders, etc.
- (d) Methods of holding work from square Turret e.g. following, drivers, guides, etc.
- (e) Precautions re clearing tap shank e.g. stop machine.

3. Die cutting short threads, by emergency methods.

- (a) Types and features of solid dies.
- (b) Types and uses of holders for solid dies.
- (c) Methods of mounting dies on the carriage e.g. square Turret, special brackets, etc.
- (d) Methods of centralizing the die.
- (e) Precautions in re-positioning die after cut-off.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A) - VERTICAL BORING MILL PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine	316
Unit 2. Work Holding Techniques	319
Unit 3. Facing Techniques	321
Unit 4. Turning Techniques	324
Unit 5. Boring Techniques	329
Unit 6. Drilling Techniques	332
Unit 7. Reaming Techniques	334
Unit 8. Miscellaneous Techniques	336

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	<ul style="list-style-type: none">(a) Names and uses of machine parts.(b) Types, features and functions of oil and grease fittings.(c) Types and features of lubricating equipment e.g. centralized, pressure, etc.(d) Lubrication methods and procedures.(e) Statistical control of lubrication e.g. schedule, charts, etc.(f) Precautions re over-lubrication of motors.(g) Precautions re spilling oil on table and floor hazard - slipping.
2. Controlling the machine	<ul style="list-style-type: none">(a) Types, features and functions of primary and secondary controls.(b) Features and functions of tool head feed mechanism e.g. feed and rapid traverse.(c) Types and features of feed trips and stops.(d) Precautions re starting machine e.g. everything clear.(e) Precautions re reading manual and instruction cards.(f) Recognition and use of hand signals used on large mills.(g) Types and features of remote control mechanisms.
3. Cleaning the machine	<ul style="list-style-type: none">(a) Cleaning techniques.(b) Cleaning schedules.(c) Types and uses of special equipment for cleaning large machines.(d) Methods of cleaning sliding bearing surfaces.(e) Precautions re use of air hose.(f) Safety practices hygiene - accidents.(g) Methods of cleaning oil reservoirs.(h) Methods of removing dirt and chips from table T-slots and chuck.
4. Adjusting the machine	<ul style="list-style-type: none">(a) Methods of adjusting moving parts.(b) Responsibility of the operator.(c) Recognition of worn parts e.g. need for adjustment.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (d) Methods of adjusting clutch and brake. (e) Reasons for gib adjustment e.g. worn part, special operations, etc. (f) Methods of adjusting locking bolts and devices. (g) Periodic recheck schedules. (h) Types and uses of tools and instruments used in adjusting machine parts. (i) Methods of compensating for wear. (j) Methods of adjusting turret head clamps.
5. Handling and mounting the following work holding accessories: Faceplate jaws Chuck jaws 3-jaw universal chuck Angle plates Clamps and accessories Special fixtures Jacks and levelling equipment Dogs and adjusting screws Drivers	<ul style="list-style-type: none"> (a) Types and features of large vertical boring mill tables. (b) Types and features of small boring mill tables e.g. integral chuck jaws. (c) Methods of handling and mounting accessories. (d) Types and features of hoisting equipment. (e) Types, features and functions of standard accessories. (f) Types and uses of tool stands. (g) Care and storage of accessories. (h) Types, uses and methods of mounting auxiliary faceplate jaws. (i) Methods of mounting a universal chuck e.g. in 4 jaw, on faceplate, etc. (j) Methods of spotting chucks for chuck wrenches. (k) Precautions re stopping table before engaging wrench. (l) Methods of handling and moving accessories and tools on large jobs e.g. cranes, bars, etc. (m) Types, features and methods of mounting chuck jaws. (n) Methods of centring and aligning accessories. (o) Types and features of pilots e.g. spigots, spacers, stops, etc. (p) Care of machine when mounting accessories.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
<p>6. Handling and mounting tool holding accessories such as:</p> <p>Combination tool heads Boring bar heads Sleeves and sleeve bushings Drill sleeves and sockets Floating reamer holders Drill holders Table brackets (wings) Special purpose tools</p>	<p>(a) Types, features and methods of mounting accessories. (b) Methods of handling and attaching Main Head accessories. (c) Methods of handling and attaching Side Head accessories. (d) Principles of tooling. (e) Care, storage and maintenance of tools and accessories. (f) Methods of centering Main Head e.g. for drilling, reaming, etc. (g) Methods of adjusting accessories. (h) Types and features of locking screws and devices. (i) Precautions re cleaning faces, spigots, etc. (j) Methods of cleaning and inspecting accessories. (k) Precautions re use of cup point setscrews. (l) Methods of handling heavy accessories. (m) Safety practices re care and methods of lifting heavy weights by hand. (n) Principles of slinging and lifting heavy accessories. (o) Methods of clamping heavy accessories for lifting. (p) Methods of mounting and truing table brackets.</p>
<p>7. Mounting the following attachments:</p> <p>Threading attachment Grinding attachment Spherical turning and Boring attachment Taper turning attachments</p>	<p>(a) Types and features of threading attachments. (b) Methods of mounting threading attachments. (c) Types and features of grinding attachments. (d) Methods of mounting grinding attachments. (e) Types, features and functions of spherical turning and boring attachment. (f) Methods of mounting spherical boring attachment. (g) Types, features and functions of taper turning attachments. (h) Methods of mounting taper turning attachments.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the method of holding work	<ul style="list-style-type: none"> (a) Types and features of available boring mills. (b) The scope of Vertical Turret Lathes, Duplex Mills, Heavy Duty Boring Mills, etc. (c) Reasons for selecting single ram, double ram, side head and extension boring mills. (d) Accuracy required. (e) Size of boring mill. (f) Simplicity of setup. (g) Types, features and functions of work holding equipment. (h) Types and uses of standard attachments e.g. special jaws, angle plates, fixtures, etc. (i) Types and uses of jigs and fixtures for special work. (j) Shape and size of work pieces.
2. Setting up work on the table	<ul style="list-style-type: none"> (a) Types and uses of standard tables e.g. plain and jawed. (b) Type of work requiring table setup. (c) Methods of mounting and clamping work on tables. (d) The theory of clamping. Physics-Mechanics. (e) Types and uses of stops, spigots and pilots for locating work. (f) Methods of counterbalancing off-centre work. (g) Types, features and functions of hold-downs, clamps and dogs e.g. strap, U, bar, fingers, etc. (h) Methods of preventing work slippage. (i) Preparation of work for table mounting. (j) Types and features of levelling equipment e.g. jacks, wedges, shims, blocks, parallels, etc. (k) Methods of blocking-up to avoid tool and table damage. (l) Sequence of operations-effect on methods of clamping. (m) Methods of handling heavy work e.g. slings, jacks, pry bars, lifts, etc. (n) Precautions re dropping heavy work proper methods of clamping, slinging and lifting. (o) Precautions re clearance of work between columns and tool heads.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS

KNOWLEDGE

2. Cont'd.

- (p) Recognition and use of signals for crane operators.
- (q) Types and uses of slings and clamps.
- (r) Methods of truing up work for average operations.
- (s) Methods of truing up precision work e.g. dial indicators, wigglers, etc.
- (t) Precaution re table speed when truing up.
- (u) Methods of inching table.
- (v) Types and uses of faceplate jaws.
- (w) Types, features and functions of extension brackets or wings.
- (x) Types and uses of aligning strips and bars.
- (y) Types and uses of step and packing blocks.
- (z) Types and uses of braces.
- (aa) Precautions reclamping of thin walled sections.
- (ab) Safety practices re loose clothing, Lifting - strains: Dropping - crushed fingers and feet.

3. Setting up work in a universal chuck

- (a) Methods of setting up and truing chuck on table.
- (b) Reasons for using a universal chuck production lots, offset work, etc.
- (c) Types and features of chuck jaws e.g. plain, soft, special, etc.
- (d) Preparation of work for holding.
- (e) Methods of protecting finished surfaces.
- (f) Limitations of the universal chuck.
- (g) Care and storage of chucks.
- (h) Methods of compensating for wear in universal chucks and jaws.

4. Setting up work on an angle plate

- (a) Types, features and functions of fixed angle plates.
- (b) Methods of mounting and truing angle plates.
- (c) Types and features of adjustable angle plates.
- (d) Methods of holding work on angle plates.
- (e) Care and storage of angle plates.
- (f) Methods of supporting overhang e.g. shims, jacks, etc.
- (g) Precautions re dirt and chips.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 2: WORK HOLDING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	(h) Precautions re distortion of thin sections when clamping. (i) Reasons for angle plate mounting.
5. Setting up work on a fixture	(a) Methods of mounting and truing table fixtures. (b) Types, features and functions of table fixtures. (c) Preparation of work for fixture mounting. (d) Care and storage of fixtures. (e) Scope of fixture-mounted work. (f) Methods of clamping work in fixtures.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 3: BASIC FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Flat facing. Work held: on the table in a chuck on an angle plate in a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Analyzing the job to determine tooling methods. (c) Factors governing method of facing. (d) Types and features of facing tools. (e) Methods of mounting facing tools, main or side head. (f) Types and uses of flat faces. (g) Types of tools for flat facing. (h) Speeds and feeds for roughing and finishing cuts. (i) Methods of setting depth of cut and feed. (j) Precautions re rapid traverse e.g. tool, machine and work damage. (k) Methods of machining multiple faces. (l) Types and uses of pin gauges and planer gauges to obtain accurate settings. (m) Types and uses of feeler gauges. (n) Calculation of speed. (o) Methods of measuring speed. (p) Selection of speeds and feeds.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 3: BASIC FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (q) Methods of testing and measuring surfaces. (r) Methods of measuring surface finish. (s) Methods of setting multiple tools and gang tools. (t) Use of plunge cut facing tools. (u) Precautions re chatter and slippage of work when using plunge cut facing. (v) Safety practices - loose clothing, flying chips, loose clamps, etc. (w) Precautions re interrupted cuts. (x) Types, features and application of coolants and lubricants. (y) Safety practices re removal of loose tools and equipment from machine before starting table. (z) Safety practices-precautions re clearances of ladders, braces, etc. under cross rail, columns, etc. (aa) Precautions re clearances of wings and projections on table. (ab) Methods of facing to a shoulder. (ac) Methods of starting and finishing a confined face e.g. T-slots, wide grooves, etc.
2. Form facing.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
Work held: <ul style="list-style-type: none"> on the table in a chuck on an angle plate in a fixture 	<ul style="list-style-type: none"> (b) Types and features of form facing tools. (c) Types and uses of formed faces. (d) Speeds and feeds for form facing. (e) Precautions re chatter. (f) Methods of testing and checking formed surfaces. (g) Types and features of tools and templates for testing and gauging formed surfaces.
3. Contour facing.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
Work held: <ul style="list-style-type: none"> on the table in a chuck on an angle plate in a fixture 	<ul style="list-style-type: none"> (b) Types and features of form facing tools. (c) Reasons for contour facing work. (d) Types and features of tracer plates and followers. (e) Methods of testing and checking contoured surfaces.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 3: BASIC FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (f) Methods of mounting tracer plates. (g) Precautions re power feed when contouring. (h) Types and features of templates and gauges for testing contoured surfaces.
4. Back-facing.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
Work held: on the table in a universal chuck on an angle plate in a fixture	<ul style="list-style-type: none"> (b) Types, features and functions of back-facing tools. (c) Speeds and feeds. (d) Chip control and disposal. (e) Back-facing procedures. (f) Reasons for back-facing. (g) Precautions re long overhand of tools e.g. breakage. (h) Methods of preventing or eliminating chatter. (i) Precautions re tool clearances. (j) Precautions re use of rapid traverse. (k) Methods of testing and measuring back faces surfaces. (l) Special care needed in placement of work-holding devices. (m) Special care needed when working blind. (n) Use of special tool heads when back-facing. (o) Finish and accuracy obtainable. (p) Precautions re interrupted cut.
5. Face forming and contouring.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
Work held: on the table in a universal chuck on an angle plate in a fixture	<ul style="list-style-type: none"> (b) Types of work requiring a contoured face. (c) Selecting the method of machining contours e.g. freehand, forming, etc. (d) Contouring procedures. (e) Types, features and functions of tools for contouring. (f) Methods of obtaining contours by freehand. (g) Use of tracer points and followers. (h) Methods of forming contours. (i) Types, features and functions of forming tools tool angles, clearances, etc. (j) Precautions re chatter. (k) Methods of measuring, testing and gauging contoured surfaces.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 3: BASIC FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Cont'd.	<ul style="list-style-type: none"> (l) Types, features and functions of gauges, instruments and templates. (m) Speeds and feeds. (n) Lubricants and coolants. (o) Production methods. (p) Methods of blending cuts. (q) Finish and accuracy obtainable. (r) Precautions re interrupted cuts.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Parallel turning. Work held: on the table in a universal chuck on an angle plate in a fixture	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Speeds and feeds for turning. (c) Types, features and functions of single point turning tools. (d) Turning procedures. (e) Chip control and disposal. (f) Methods of mounting tools Physics-Mechanics, forces. (g) Rapid traverse controls. (h) Precautions re use of rapid traverse Tool and work damage. (i) Calculations for speeds. (j) Types and features of measuring instruments for diameter. (k) Methods of turning a full cylinder e.g. blocking up from table, reversing clamps, etc. (l) Methods of turning to a shoulder. (m) Accuracy obtainable. (n) Methods of obtaining required surface finish. (o) Production methods multiple and combined cuts. (p) Care and storage of measuring tools and instruments. (q) Recognition of dull or worn tools. (r) Calculating turning time. (s) Allowances for finishing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (t) Reasons for using Main or Side heads. (u) Interpretation of specifications e.g. blueprints, tooling cards, etc. (v) Methods of Form Turning. (w) Type and features of form turning tools. (x) Diagnosis and correction of turning troubles. (y) Precautions re interference of main and side heads in combined cuts. (z) Principles of Metal Cutting. (aa) Safety practices-use of guards, goggles, face shields, etc. (ab) Safety precautions re stopping machine when measuring. (ac) Safety practices re dress e.g. loose clothing, safety shoes, etc. (ad) Safety re falling cuttings in very large work. (ae) Standard signals to crane operators. (af) Precautions re use of rapid traverse. (ag) Types, features and application of coolants and lubricants. (ah) Precautions re interrupted cuts. (ai) Precautions re clearances of ladders, wings, projections, etc. between columns and under cross rails, tool heads, etc. (aj) Starting and finishing confined surfaces e.g. T-slots, wide grooves, etc. (ak) Methods of turning in deep recesses. (al) Precautions re measuring warm work. (am) Effect of heat on size Physics - heat expansion.
2. Turning a taper or cone.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Methods of angular cutting e.g. swivel head, taper plate, combination feed, angle bars, etc. (c) Taper calculations. (d) Methods of swivelling and setting ram angle. (e) Limitations in use of swivelled ram. (f) Methods of setting and checking taper plates.
Work held: on the table in a universal chuck on an angle plate in a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (g) Methods of disconnecting ram feed when using taper plates. (h) Methods of feeding when using taper plates. (i) Limitations in use of taper plates e.g. time factor. (j) Procedures in setting combined feeds. (k) Calculations for obtaining angles by combined feeds. (l) Calculations for angles by combined feeds and swivelling head. (m) Limitations and use of combined feeds. (n) Use and limitations of angle bars. (o) Methods of setting angle bars e.g. in side head. (p) Methods of holding and positioning guide rollers. (q) Methods of measuring and testing angles. (r) Methods of setting and positioning tools e.g. on centre, etc. (s) Types and uses of forming tools. (t) Methods of cutting angles by forming. (u) Factors governing method of turning tapers. (v) Speed and feeds for tapering. (w) Types, features and uses of angle measuring instruments. (x) Care and storage of angle measuring. (y) Precautions re wedging of tools when cutting to a shoulder. (z) Tool clearances when cutting to a shoulder. (aa) Methods of setting angle of tool for chamfers and bevels when forming. (ab) Precautions re chattering.
3. Parting, grooving and necking.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types and uses of grooves and undercuts. (c) Types and uses of grooving tools. (d) Types and applications of shoulders. (e) Methods of gauging and measuring grooves. (f) Types, features and functions of parting tools. (g) Speeds and feeds.
Work mounted: on the table in a universal chuck on an angle plate on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (h) Types and uses of spring-tool holders. (i) Methods of cutting undercuts e.g. T-slots, dovetail slots, etc. (j) Preparation of work for undercutting. (k) Methods of removing heavy sections after complete cut off. (l) Methods of multiple grooving. (m) Methods of spacing grooving tools. (n) Methods of controlling depth of grooves. (o) Precautions re tool clearances. (p) Precautions re tools wedging. (q) Safety practices - care needed in handling parted-off work sharp fins, dropping, burns, etc. (r) Methods of removing fins and sharp edges. (s) Types, features and functions of combination tools e.g. parting and forming tools, grooving and chamfering tools, etc. (t) Finish and accuracy obtainable.
4. Turning and forming contours.	<ul style="list-style-type: none"> (a) Methods of mounting work as B1, U2, O2, 3, 4, 5. (b) Types of work requiring contouring. (c) Selecting the method of cutting contours e.g. freehand, attachments, etc. (d) Freehand contouring methods. (e) Types, features and uses of contouring attachments. (f) Operating procedures. (g) Methods of forming contours. (h) Types, features and functions of tools used for forming and contouring. (i) Speeds and feeds. (j) Production methods. (k) Methods of testing, gauging and measuring contoured surfaces. (l) Types, features and functions of gauges, templates and instruments for measuring contours. (m) Precautions re tool clearances. (n) Precautions re chatter Physics-Resonance. (o) Methods of blending cuts to straight or curved surfaces e.g. radii, fillets, etc. (p) Accuracy obtainable.
Work held: on the table on a universal chuck on an angle plate on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	(q) Types, uses and application of coolants and lubricants. (r) Precautions re interrupted cut.
5. Spherical Turning. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Spherical turning procedures. (c) Types, features and uses of spherical turning attachments. (d) Methods of setting up and adjusting spherical turning attachments. (e) Methods of turning spherical surfaces freehand. (f) Testing, measuring and gauging spherical surfaces. (g) Types, features and functions of tools, gauges and templates for spherical surfaces. (h) Types and uses of tracer points and followers. (i) Speeds and feeds. (j) Methods of form cutting spherical surfaces. (k) Types and features of tools for spherical turning. (l) Precautions re tool clearances. (m) Methods of preventing and eliminating chatter. (n) Selecting the method of machining e.g. spherical turning attachment, freehand, tracer points and followers, etc. (o) Accuracy obtainable. (p) Precautions re interrupted cuts. (q) Methods of starting and/or finishing confined spherical surfaces.
6. Eccentric Turning Work held: on the table in a universal chuck on an angle plate in a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Layout procedures. (c) Methods of offsetting. (d) Calculations for offsetting. (e) Methods of measuring offset. (f) Speeds and feeds for eccentric turning. (g) Methods of balancing offset work.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 4: BASIC TURNING TECHNIQUES

OPERATIONS	KNOWLEDGE
6. Cont'd.	(h) Safety practices - Correct speed to prevent throw-out. (i) Precautions re starting out.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 5: BASIC BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Boring a through parallel hole. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Selecting tools. (c) Methods of mounting tools. (d) Types, features and uses of boring tools and heads. (e) Boring procedures. (f) Speeds and feeds for roughing and finishing cuts. (g) Allowances for finishing. (h) Accuracy and finish obtainable. (i) Methods of chip control and disposal. (j) Methods of testing, measuring and gauging bores. (k) Types, features and functions of bore measuring tools e.g. inside micrometers, pin gauges, inside calipers, etc. (l) Accuracy obtainable with various bore measuring tools. (m) Effect of heat on size Physics - heat. (n) Precautions re measuring bores while warm. (o) Types, uses and application of coolants and lubricants. (p) Precautions re interrupted cuts. (q) Methods of preparing split work for boring. (r) Operating precautions re set up to avoid table and tool damage e.g. blocking up. (s) Safety practices - danger from flying chips, loose pieces, etc. (t) Safety practices - danger from tools bumping head when inspecting bore, etc. (u) Operating precautions re clearances of projections, ladders, etc., under rams and between columns, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 5: BASIC BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (v) Methods of boring deep bores. (w) Principles of metal cutting. (x) Methods of forming shallow bores. (y) Reasons for using main or side heads. (z) Recognition of dull or worn tools. (aa) Production methods multiple and combined cuts. (ab) Methods of reverse counter boring. (ac) Methods of cutting oil grooves. (ad) Precautions re use of rapid traverse. (ae) Methods of boring partial holes. (af) Standard crane signals.
2. Boring a blind parallel hole.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Selecting the method of mounting tools. (c) Boring procedures. (d) Methods of controlling depth. (e) Types, features and functions of cutters for blind hole boring. (f) Types, features and uses of depth measuring tools and instruments. (g) Methods of facing bottom of bores. (h) Methods of step boring. (i) Production methods. (j) Methods of chip control and disposal. (k) Methods of starting and/or finishing confined surfaces. (l) Methods of internal grooving, recessing, forming and contouring. (m) Precautions re bottoming. (n) Methods of forming shallow bores. (o) Methods of testing, checking, measuring and gauging internal grooves, recesses and contours. (p) Methods of boring and forming internal spherical surfaces. (q) Types and features of bars and tools for grooving, recessing, forming and contouring bores.
Work held: on the table in a universal chuck on an angle plate in a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 5: BASIC BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Boring a through or blind tapered hole.	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5.
Work held:	(b) Selecting the method of taper boring.
on the table	(c) Factors governing the use of various methods.
in a universal chuck	(d) Taper calculations.
on an angle plate	(e) Methods of swivelling and setting ram angle.
in a fixture	(f) Limitations in use of swivelled ram.
	(g) Methods of setting and checking taper plates.
	(h) Methods of disconnecting ram feed when using taper plates.
	(i) Methods of feeding when using taper plates.
	(j) Limitations in use of taper plates.
	(k) Procedures in setting combined feeds.
	(l) Calculations for obtaining angles by confined feeds.
	(m) Calculations for angles by combined feeds and swivelling head.
	(n) Limitations and use of combined feeds.
	(o) Use and limitations of angle bars.
	(p) Methods of holding and positioning guide rollers.
	(q) Methods of measuring and testing bores.
	(r) Methods of setting and positioning tools e.g. on centre, etc.
	(s) Types and uses of tools for taper forming.
	(t) Methods of setting taper forming tools.
	(u) Speeds and feeds.
	(v) Types, features and use of angle measuring tools and instruments.
	(w) Precautions re wedging of tools when cutting to shoulder e.g. commutator undercuts.
	(x) Tool clearances when cutting to a shoulder.
	(y) Methods of setting tool angles for internal chamfers and bevels when forming.
	(z) Precautions re chattering.
	(aa) Safety practices re flying chips and pieces - use of goggles and face shields.
	Falling cuttings in large work.
	(ab) Precautions re bottoming in blind taper bores.
	(ac) Precautions re interrupted cuts.
	(ad) The relationship of bar size to bore size.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 5: BASIC BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	(ae) Precautions re wedging boring blind tapered hole.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 6: BASIC DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Spotting for drilling. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Preparation of work for spotting. (c) Methods of theory of spotting. (d) Requirements of a true spot e.g. size, angle, etc. (e) Types, features and functions of spotting tools. (f) Speeds and feeds. (g) Types and application of cutting compounds. (h) Specifications i.e. accuracy of job. (i) Operating precautions - clearance of work and projections under rails and between columns. (j) Safety practices - hazard from loose pieces on table, chuck wrenches, etc. (k) Precautions re use of rapid traverse. (l) Standard signals for crane operators.
2. Drilling a hole from solid. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Types, features and functions of drills for various materials. (c) Methods of holding and removing drills. (d) Methods and theory of drilling. (e) Drilling procedures. (f) Selection of speeds and feeds. (g) Types and application of cutting compounds. (h) Chip control and disposal. (i) Methods of feeding drill. (j) Specifications of hole re accuracy. (k) Methods of gauging and measuring holes. (l) Types, features and functions of hole gauges and measuring instruments.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 6: BASIC DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (m) Diagnosis and control of drilling trouble. (n) Methods of drilling deep holes. (o) Precautions re break through and spring back. (p) Methods of controlling depth. (q) Methods of measuring and gauging depth. (r) Production methods. (s) Types and uses of drill extensions. (t) Operating precautions to prevent drill breakage:- correct feeds, care in using rapid traverse, centring ram. (u) Safety practices re hot, sharp cuttings. (v) Drill nomenclature. (w) Types, features and functions of drill adaptors. (x) The theory of pilot hole drilling. (y) Methods of finishing hole bottoms. (z) Types, features and uses of various shaped hole bottoms. (aa) Types and features of hole bottoming drills and tools.
3. Drilling a stepped hole from solid, counter drilling	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Reasons for counter drilling. (c) Types, features and functions of step drills and drilling tools. (d) Methods of piloting tools. (e) Methods of setting inserted cutters. (f) Counter drilling procedures. (g) Methods of testing and measuring stepped holes. (h) Operating precautions - centring counter drills use of rapid traverse. (i) Speeds and feeds. (j) Roughing and finishing cuts. (k) Accuracy and finish obtainable. (l) Recognition of dull and worn tools.
Work held: on the table in a universal chuck on an angle plate on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 6: BASIC DRILLING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Drilling a cored hole. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4, and 5. (b) Types, features and functions of core drills. (c) Drilling procedures. (d) Preparation of work for core drilling. (e) Speeds and feeds. (f) Reasons for core drilling. (g) Methods of starting drill true. (h) Diagnosis and correction of drilling troubles. (i) Operating precautions - care in drilling out of round, caved in, warped, etc. holes.
5. Countersinking, counterboring and spot facing. Work held: on a table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Types, features and functions of counterbores, countersinks, and spot facing tools. (c) Methods of controlling depth. (d) Speeds and feeds. (e) Countersinking, counterboring and spot facing procedures. (f) Types, features and functions of combination tools. (g) Precautions re seized pilots.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 7: BASIC REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Reaming a parallel hole. Work held: on the table in a universal chuck on an angle plate on a fixture	(a) Methods of mounting work as B8, U2, O2, 3, 4 and 5. (b) Requirements of the finished hole e.g. accuracy, finish, concentricity, etc. (c) Preparation of work for reaming. (d) The theory of reaming. (e) Types, features and functions of hand and machine reamers. (f) Allowances for reaming. (g) Speeds and feeds.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 7: BASIC REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (h) Types and application of cutting compounds. (i) Methods of mounting reamers. (j) Care in handling and storing reamers. (k) Reamer nomenclature. (l) Types, features and functions of reamer holders. (m) Methods of reaming interrupted bores. (n) Methods of testing, gauging and measuring reamed holes. (o) Prevention of bell mouthing. (p) Methods of starting reamers true. (q) Precautions re use of rapid traverse. (r) Diagnosis and correction of reaming. (s) Precautions re bottoming when reaming blind holes. (t) Methods of reaming blind holes. (u) Precautions re gauging hot work e.g. seizing of gauge. (v) Accuracy obtainable. (w) Methods of testing and measuring reamers. (x) Safety practices re handling reamers. (y) Allowances in depth for reaming blind holes. (z) Chip control and disposal. (aa) Types, features and uses of stepped reamers. (ab) Methods of reaming stepped holes. (ac) Knowledge and use of signals for crane operators.
2. Reaming a tapered hole.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types, features and functions of tapered holes. (c) Types and uses of tapered reamers. (d) Allowances for taper reaming. (e) Preparation of work. (f) Methods of testing and gauging tapers. (g) Types and features of tools, instruments and gauges for checking tapers. (h) Chip control and disposals. (i) Methods of controlling or eliminating chatter. (j) Speeds and feeds. (k) Reaming procedure. (l) Kinds and uses of tapers.
Work held:	
on the faceplate	
in a universal	
chuck	
on an angle plate	
on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 7: BASIC REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (m) Precautions re grabbing. (n) Methods of reaming steep-taper holes. (o) Operating precautions e.g. jamming, sticking bottom, etc. (p) Care and storage of taper reaming. (q) Types and applications of cutting compounds. (r) Precautions re chip interference.

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 8: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Spherical boring. Work held: on the table in a universal chuck on a fixture	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 5. (b) Types of work requiring spherical boring. (c) Methods of setting and checking spherical boring tools. (d) Spherical boring procedures. (e) Methods of measuring and testing internal spherical surfaces. (f) Types and uses of tools and gauges for testing and checking internal spherical surfaces. (g) Accuracy and finish obtainable. (h) Precautions re clearances of tools and rams. (i) Methods of starting and finishing confined cuts. (j) Precautions re depth of cut lack of rigidity of setup.
2. Chasing an external or internal thread. Work held: on the table in a universal chuck on an angle plate on a fixture	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types of work requiring threading. (c) Types and features of threading attachments for various types of boring mills. (d) Methods of setting and checking threading attachments. (e) Speeds for threading. (f) Limitations of threading attachments.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE

UNIT 8: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (g) Types, features and functions of various threads and thread forms. (h) Types, features and functions of tools for threading. (i) Methods of testing, checking and gauging threads. (j) Types and features of thread measuring tools and instruments. (k) Accuracy obtainable. (l) Depth of cut. (m) Methods of returning to start. (n) Calculations for threads. (o) Calculations to obtain correct gears for gear train. (p) Threading procedures. (q) Method of obtaining positive feed. (r) Method of disconnecting feed clutch. (s) Factors governing method of cutting threads i.e. relative speed, accuracy, etc. (t) Use of chasing dial when using lead screw method. (u) Method of feeding lead screw. (v) Method of setting chasing dial for thread to be cut. (w) Preparation of work for threading. (x) Diagnosis and correction of threading troubles. (y) Methods of mounting tools.
3. Tapping a hole.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
Work held: on the table in a universal chuck on an angle plate on a fixture	<ul style="list-style-type: none"> (b) Types of work requiring tapping. (c) Methods of starting taps true. (d) Types, features and functions of taps, tap holders and wrenches. (e) Tapping procedures. (f) Preparation of work for tapping. (g) Calculations for tap drill size. (h) Diagnosis and correction of tapping troubles. (i) Speeds for tapping. (j) Precautions re use of power when tapping. (k) Methods of feeding tap. (l) Precautions re bottoming in blind holes.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 8: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (m) Types, features and application of cutting compounds. (n) Nomenclature and specifications of standard taps. (o) Methods of controlling depth of thread. (p) Precaution re breaking taps. (q) Methods of measuring and testing threaded holes. (r) Methods of removing taps e.g. drop through, backing out, etc. (s) Methods of mounting taps and holders.
4. Die cutting a thread.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Reasons for cutting a thread with a die. (c) Accuracy obtainable. (d) Types, features and functions of solid and releasing dies. (e) Types and uses of die heads and holders. (f) Methods of mounting dies. (g) Die cutting procedures. (h) Preparation of work for die cutting. (i) Speeds for die cutting. (j) Methods of feeding dies. (k) Nomenclature and specifications of standard dies. (l) Methods of measuring and gauging threads. (m) Methods of backing off dies. (n) Operating precautions e.g. striking shoulders, oversize parts, etc. (o) Methods of adjusting dies. (p) Use and limitations of die cut threads. (q) Types, features and applications of cutting compounds.
Work held: on the table in a universal chuck on an angle plate on a fixture	
5. Knurling.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 5. (b) Types of work requiring knurling. (c) Types, features and functions of knurling tools. (d) Methods of mounting knurling tools. (e) Reasons for knurling. (f) Types and uses of various knurl patterns. (g) Speeds and feeds.
Work held: on the table on a universal chuck on a fixture	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(A): VERTICAL BORING MILL PRACTICE UNIT 8: MISCELLANEOUS TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Cont'd.	(h) Types and applications of lubricants for knurling. (i) Knurling procedures. (j) Diagnosis and correction of knurling troubles. (k) Safety practices - re fingers, lubricating equipment, rags, etc. being caught. (l) Preparation of work. (m) Operating precautions re knurling to a shoulder.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B) - HORIZONTAL BORING MILL PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	341
Unit 2. Work Holding Techniques.....	343
Unit 3. Facing Techniques.....	345
Unit 4. Drilling and Reaming Techniques.....	347
Unit 5. Boring Techniques.....	348
Unit 6. Miscellaneous Techniques.....	351

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Cleaning the machine	<ul style="list-style-type: none">(a) Types, features and functions of solvents and cleaners.(b) Cleaning techniques.(c) Cleaning schedules.(d) Types, features and functions of equipment for cleaning.(e) Methods of cleaning oil reservoirs.(f) Methods of cleaning T-slots.(g) Methods of cleaning coolant tanks, filters, etc.(h) Effect of cutting oils on machine surfaces.(i) Precautions re use of air hose.(j) Safety practices re cleaning machine while in operation.
2. Oiling the machine	<ul style="list-style-type: none">(a) Names and functions of machine parts.(b) Kinds, uses and selection of lubricants.(c) Lubricating methods and procedures.(d) Types, features and use of lubricating equipment e.g. centralized, unitized, etc.(e) Precautions re over lubrication of motors.(f) Precautions re oil, grease, etc. on floor, tables, etc.(g) Types, features and functions of sight oilers, oil cups, grease cups, etc.(h) Types and use of oil reservoir, oil level indicators.(i) Lubrication schedules.
3. Controlling the machine	<ul style="list-style-type: none">(a) Types, features and functions of primary controls.(b) Types and features of secondary controls e.g. headstock, table, etc.(c) Types, features and use of remote control equipment.(d) Rapid traverse controls.(e) Coolant system controls.(f) Precautions re starting machine i.e. everything clear.(g) Safety practices re safe clothing, shoes, etc.(h) Operating precautions - need for understanding controls, mechanisms, etc., before starting machine.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
4. Adjusting the machine	<ul style="list-style-type: none"> (a) Methods of adjusting moving parts. (b) Responsibility of the operator. (c) Recognition of worn parts and need for adjustment. (d) Procedures and equipment for testing machine. (e) Methods of determining causes of error. (f) Methods of adjusting locking bolts, levers, etc. (g) Periodic recheck schedules. (h) Methods of compensating for wear. (i) Types, features and functions of tools used in adjusting parts.
5. Handling and mounting the following accessories:	<ul style="list-style-type: none"> (a) Types, features and functions of standard accessories. (b) Handling and mounting accessories. (c) Care, storage and mounting accessories. (d) Methods of testing and checking mounted accessories. (e) Types, features and functions of lifting and handling equipment. (f) Types, features and functions of indicating equipment (g) Types and uses of tools and wrenches for mounting accessories. (h) Precautions re cleanliness of mating parts. (i) Safety practices re use of lifting and handling equipment.
Horizontal rotary tables	
Vertical rotary tables	
Universal tilting rotary tables	
Angular milling attachments	
Continuous feed facing head	
Over arm supports	
Milling arbors and supports	
Boring bars and supports	
Cross rail over arm supports	
Vertical boring and milling attachments	
Side and end milling attachments	
Star feed facing attachment	
Auxiliary tables	
Compound rests	
Lathe tool holders	
Chucks, faceplates and spindle accessories	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 2: WORK HOLDING
TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the machine and method of holding work	<ul style="list-style-type: none"> (a) Selecting the machine and accessories. (b) Type of work and operations to be performed. (c) Accuracy required on the job. (d) Number of parts to be machined. (e) Capacity of the machine. (f) Methods of locating accessories on table floor, etc. (g) Shape and size of work pieces. (h) Types, features and functions of jigs and fixtures. (i) Types, features and functions of work holding devices. (j) Reason for selecting table, floor or planer type mills. (k) Reasons for selecting single or double spindle machine. (l) Types, features and uses of multiple head machines. (m) Types and uses of jacks.
2. Setting up work on the table	<ul style="list-style-type: none"> (a) Types and features of work usually machined on the table. (b) Types, features and functions of table type machines. (c) Types, features and functions of planer type machines. (d) The scope of table type machines. (e) Simplicity of setup. (f) Number of operations to be performed. (g) The number of parts to be machined. (h) Types, features and functions of clamping equipment e.g. hold downs, clamps, dogs, fingers, braces, etc. (i) The relative accuracy of various methods of setting up work. (j) Reasons for table setup. (k) Methods of aligning and locating large pieces. (l) Recognition and use of standard signals for crane operators. (m) Types and uses of levelling and jacking equipment. (n) Types, features and functions of auxiliary tables.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 2: WORK HOLDING
TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (o) Procedures used for truing up work. (p) Setup procedures. (q) Operating precautions re slinging and lifting; danger from dropping or bumping large pieces. (r) Safety practices re crushed hands and feet, etc. (s) Methods of lifting and moving work. (t) Precautions re clamping down rough work; need for shimming. (u) Types, features and functions of square, rectangular and round tables. (v) Types, features and use of extension saddles. (w) Types and uses of indicating equipment. (x) Types and uses of stops, spigots, pilots, locating strips, etc. (y) Types and uses of parallels, shims, wedges, jacks, box parallels, etc. (z) Methods of preventing work slippage. (aa) Preparation of work for table mounting.
3. Setting up work on fixtures	<ul style="list-style-type: none"> (a) Types, features and functions of standard and special fixtures. (b) Methods of setting and truing fixtures. (c) Types of work requiring fixture mounting. (d) Setup procedures. (e) Methods of locating and holding work in fixtures. (f) Types, features and use of angle plates and off angle plates.
4. Setting up work on a rotary table	<ul style="list-style-type: none"> (a) Types, features and functions of plain and universal tables. (b) Types, features and use of vertical rotary tables. (c) Methods of setting up, locating and holding rotary tables. (d) Methods of mounting work on rotary tables. (e) Methods of setting up power trains for rotary tables.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 2: WORK HOLDING
TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Cont'd.	<ul style="list-style-type: none"> (f) Types, features and use of indicating equipment. (g) Care, maintenance and storage of rotary tables. (h) Types, features and functions of universal tilting rotary tables.
5. Setting up work on the floor	<ul style="list-style-type: none"> (a) Types and features of floor type machines. (b) Types and features of work requiring use of floor type machine. (c) The scope of floor type machines. (d) Types, features and functions of work holding equipment. (e) Setup procedures. (f) Methods of lifting, locating, blocking and clamping work. (g) Recognition and use of crane operator's signals. (h) Types, features and functions of indicating equipment. (i) Relative accuracy of various setups. (j) Precision setup procedures. (k) Location of work with regard to boring mill. (l) Location of clamping devices to clear cutters, tools, etc. (m) Location of clamping devices in multiple head machines.

BLOCK XII B: HORIZONTAL BORING MILL PRACTICE

UNIT 3: FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Flat facing, using single point tools.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types, features and functions of star feed facing heads. (c) Types, features and functions of continuous feed facing heads. (d) Types, features and functions of boring bar mounted fly cutters.
Work held: on the table on a fixture on a rotary table on the floor	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 3: FACING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (e) Types, features and functions of boring bar, face forming heads. (f) Facing procedures. (g) Back facing procedures. (h) Methods of mounting facing heads and cutters. (i) Design of facing cutters. (j) Speeds and feeds. (k) Types and features and uses of extension bars for facing heads. (l) Types, features and uses of cutting compounds. (m) Types of work requiring facing with single point tools. (n) Methods of measuring and testing surfaces. (o) Surface finish and accuracy obtainable. (p) Types and features of measuring tools and devices. (q) Operating precautions re use of rapid traverse. (r) Safety practices re rotating tools-loose clothing. (s) Types, features and functions of verniers and measuring rods.
2. Flat facing, using multiple point tools.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types, features and functions of multiple point tools. (c) Methods of mounting tools. (d) Method of feeding work. (e) Sequence of operations. (f) Precautions re machine and cutter damage by feeding too far. (g) Methods of mounting tools and tool heads. (h) Types and use of remote control equipment. (i) Methods of working and measuring in confined spaces. (j) Methods of machining surfaces parallel or at specific angles.
Work held: on the table on a fixture on a rotary table on the floor	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL BRactice

UNIT 4: DRILLING AND REAMING
TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Drilling a through or blind hole.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on a fixture on a rotary table on the floor 	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5, (b) Methods of mounting drills. (c) Methods of aligning drill and layout. (d) Methods of spotting for drilling. (e) Preparation of work for drilling. (f) Speeds and feeds for drilling. (g) Methods of feeding drill or work. (h) Choice of spindles in two spindle head-stocks. (i) Types and uses of cutting compounds. (j) Accuracy obtainable. (k) Types, features and specifications of drills. (l) Drilling procedures. (m) Methods of drilling holes in solid and cored work. (n) Chip control and disposal. (o) Methods of testing and measuring holes. (p) Methods of accurately spacing holes. (q) Methods of controlling depth. (r) Methods of measuring depth. (s) Types and uses of drill extensions. (t) Methods of drilling equally spaced holes in line or radially.
<p>2. Reaming a through or a blind hole.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on a fixture on a rotary table on the floor 	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Methods of mounting reamers and reamer holders. (c) Preparation of work for reaming. (d) Speeds and feeds. (e) Methods of feeding reamers or work. (f) Types and uses of cutting compounds. (g) Types, features and specifications of reamers. (h) Reaming procedures. (i) Chip disposal. (j) Methods of measuring and gauging holes. (k) Precautions re gauging holes. (l) Precautions re bottoming in blind holes. (m) Methods of controlling depth. (n) Precautions re chip interference in hole bottoms.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 4: DRILLING AND REAMING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Countersinking, counter-boring, spot facing and back facing a hole.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Types, features and functions of various tools.</p> <p>(c) Countersinking, counterboring, spot facing and back facing procedures.</p> <p>(d) Methods of controlling and measuring depth.</p> <p>(e) Speeds and feeds.</p> <p>(f) Types, features and uses of combination tools.</p> <p>(g) Precautions re binding of pilots.</p> <p>(h) Methods of testing and inspecting.</p> <p>(i) Design of tools for various operations.</p>

BLOCK XII B: HORIZONTAL BORING MILL PRACTICE

UNIT 5: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Boring a through hole.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Types, features and functions of boring tools.</p> <p>(c) Design of boring tools and heads.</p> <p>(d) Methods of mounting tools.</p> <p>(e) Methods of setting tools for diameter.</p> <p>(f) Methods of supporting long boring bars.</p> <p>(g) Types and features of offset boring bars.</p> <p>(h) Methods of mounting and setting offset boring bars.</p> <p>(i) Types and features of bore measuring instruments.</p> <p>(j) Methods of centring work or tool to layout.</p> <p>(k) Methods of recentring work or tool to bored hole.</p> <p>(l) Methods of aligning work or tool to reference surfaces.</p> <p>(m) Types, features and functions of indicators for truing up.</p> <p>(n) Methods of boring holes in alignment.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 5: BORING TECHNIQUES

OPERATIONS

KNOWLEDGE

1. Cont'd.

- (o) Precautions re chatter.
- (p) Accuracy and finish obtainable.
- (q) Methods of measuring bore.
- (r) Precautions re use of rapid traverse.
- (s) Methods of feeding boring bars or work.
- (t) Boring procedures.
- (u) Precision boring methods.

2. Boring a blind hole.

Work held:

on the table
on a fixture
on a rotary table
on the floor

- (a) Methods of mounting work as B8, U2, O2, 3, 4, 5.
- (b) Blind hole boring procedures.
- (c) Preparation of work for boring.
- (d) Methods of measuring or gauging depth.
- (e) Types and features of depth measuring instruments.
- (f) Methods of finishing hole bottoms.
- (g) Types and features of tools for blind boring.
- (h) Methods of setting and adjusting.
- (i) Methods of controlling depth.
- (j) Use of table or headstock verniers.
- (k) Chip control and disposal.
- (l) Accuracy and finish obtainable.
- (m) Methods of mounting tools.
- (n) Operating precautions re bottoming.
- (o) Safety practices re use of air blast.
- (p) Methods of boring tapered holes.
- (q) Types and features of tools for boring and forming tapered holes.
- (r) Calculations for tapers.
- (s) Methods of testing and gauging tapers.
- (t) Methods of boring a partial hole.
- (u) Precautions re interrupted cuts.
- (v) Precautions re use of rapid traverse.
- (w) Relative accuracy of spindle feed and table feed in deep holes.
- (x) Types, features and use of multiple tool boring heads.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 5: BORING TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>3. Counterboring and step boring.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Types, features and use of tools and heads for counter boring.</p> <p>(c) Counterboring procedures.</p> <p>(d) Methods of gauging and measuring counter-bored holes.</p> <p>(e) Methods of depth control e.g. multiple stops.</p> <p>(f) Speeds and feeds.</p> <p>(g) Types and features of forming tools for flat and formed steps (faces).</p>
<p>4. Grooving and undercutting a bore.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Reasons for grooving and undercutting.</p> <p>(c) Types and uses of grooves.</p> <p>(d) Methods of undercutting.</p> <p>(e) Types and features and design of tools for grooving.</p> <p>(f) Methods of setting tools.</p> <p>(g) Methods of obtaining radial feed.</p> <p>(h) Types and features of retracting cutter bars.</p> <p>(i) Precautions re withdrawal of tool from bore.</p> <p>(j) Methods of measuring grooves and undercuts.</p>
<p>5. Line boring.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Reasons for line boring.</p> <p>(c) Methods of setting, testing and truing for line boring.</p> <p>(d) Types, features and functions of boring bars.</p> <p>(e) Production methods: use of multiple cutters.</p> <p>(f) Methods of setting cutters.</p> <p>(g) Methods of supporting boring bars.</p> <p>(h) Precautions re withdrawal of boring bar when using overarm supports.</p> <p>(i) Methods of accurately spacing holes.</p> <p>(j) Types, features and use of support bushings.</p> <p>(k) Types, features and functions of boring heads for large diameter work.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 6: MISCELLANEOUS
TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>1. Tapping a hole, through or blind.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on a fixture on a rotary table on the floor 	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types, uses and specifications of standard taps, straight and tapered. (c) Terminology and specifications of threads. (d) Types, features and functions of tap holders. (e) Calculations for tap drill sizes. (f) Speeds for tapping. (g) Types, features and application of cutting compounds. (h) Methods of gauging, testing and measuring tapped holes. (i) Preparation of work for tapping. (j) Diagnosis and correction of tapping troubles. (k) Methods of controlling length of thread. (l) Types, features and functions of thread measuring tools, gauges and instruments. (m) Precautions re bottoming. (n) Methods of feeding taps. (o) Care and storage of taps. (p) Tapping sequence. (q) Tapping procedures. (r) Depth for taper tapping. (s) Types and features of work requiring tapping. (t) Methods of tapping small holes, use of auxiliary spindle. (u) Method of de-clutching main spindle. (v) Methods of removing taps.
<p>2. Die cutting a thread, straight or tapered.</p> <p>Work held:</p> <ul style="list-style-type: none"> on the table on a fixture on a rotary table on the floor 	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Method of mounting dies. (c) Types, features and functions of die heads. (d) Terminology and specifications of threads. (e) Methods of adjusting dies. (f) Preparation of work. (g) Speeds for threading. (h) Types and uses of cutting compounds. (i) Threading procedures. (j) Types and features of thread endings and thread starts.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 6: MISCELLANEOUS
TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (k) Methods of threading to a shoulder. (l) Chip control and disposal. (m) Methods of measuring, testing and gauging. (n) Types, features and functions of thread measuring instruments. (o) Types of threads usually die cut, straight and taper. (p) Methods of adjusting taper threading dies. (q) Methods of backing off dies.
3. Screw cutting an external thread.	<ul style="list-style-type: none"> (a) Methods of mounting work as B8, U2, O2, 3, 4, 5. (b) Types, features and specifications of various threads. (c) Thread nomenclature and terminology. (d) Reasons for screw cutting threads. (e) Threading procedures. (f) Methods of measuring and gauging threads. (g) Methods of grinding, gauging and testing threading tools. (h) Types, uses and care of thread measuring tools and gauges. (i) Speeds for threadings. (j) Types of machines which can be used to cut threads. (k) Types, features and use of headstocks equipped with precision thread lead devices. (l) Methods of setting up lead screw for threading. (m) Methods of setting change gears. (n) Calculations for threading. (o) Methods of catching the thread, use of threading dial. (p) Method of controlling depth of cut, use of continuous feed facing head, offset boring bars, etc. (q) Methods of returning to start. (r) Method of cutting right and left hand threads. (s) Diagnosis and correction of threading troubles. (t) Preparation of work for threading. (u) Methods of finishing start of thread.
Work held: on the table on a fixture on a rotary table on the floor	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE

UNIT 6: MISCELLANEOUS
TECHNIQUES

OPERATIONS	KNOWLEDGE
<p>4. Screw cutting an internal thread.</p> <p>Work held: on the table on a fixture on a rotary table on the floor</p>	<p>(a) Methods of mounting work as B8, U2, O2, 3, 4, 5.</p> <p>(b) Internal thread cutting procedures.</p> <p>(c) Methods of holding and setting threading tools.</p> <p>(d) Preparation of work for threading.</p> <p>(e) Methods of obtaining in-feed.</p> <p>(f) Methods of threading a blind bore.</p> <p>(g) Speeds for threading.</p> <p>(h) Calculations for bore size.</p> <p>(i) Types and uses of thread endings.</p> <p>(j) Methods of finishing thread starts, chamfer, radii, etc.</p> <p>(k) Methods of testing, measuring and gauging internal threads.</p> <p>(l) Types, features and use of thread measuring instruments.</p> <p>(m) Precautions re tool overhang.</p> <p>(n) Precautions re bottoming.</p> <p>(o) Types of work requiring internal screw cutting.</p> <p>(p) Types, features and functions of tool adjustment gauges.</p> <p>(q) Methods of obtaining left or right hand lead.</p> <p>(r) Method of backing up cutter to prevent return drag.</p>
<p>5. Machining work held on the spindle</p>	<p>(a) Methods of holding and mounting work e.g. centres, chucks, faceplates, etc.</p> <p>(b) Emergency methods of machining work.</p> <p>(c) Types, features and functions of turning, boring, facing, etc., tools.</p> <p>(d) Methods of mounting tools.</p> <p>(e) Methods of feeding.</p> <p>(f) Cutting speeds and feeds.</p> <p>(g) Reasons for using boring mill for lathe-type work.</p> <p>(h) Methods of gauging, testing and measuring.</p> <p>(i) Machining procedures.</p> <p>(j) Operating precautions re care in handling, mounting and machining.</p> <p>(k) Types, features and functions of tool holding equipment.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XII(B): HORIZONTAL BORING MILL PRACTICE UNIT 6: MISCELLANEOUS
TECHNIQUES

OPERATIONS

KNOWLEDGE

5. Cont'd.

- (1) Methods of mounting tool holding equipment.
- (m) Safety practices re revolving work, flying chips, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII - BROACHING PRACTICE

TABLE OF CONTENTS

	PAGE
Unit 1. The Machine.....	356
Unit 2. The Broach.....	357
Unit 3. Internal Broaching Techniques.....	359
Unit 4. Broach Grinding Techniques.....	361

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
1. Oiling the machine	<ul style="list-style-type: none">(a) Names and functions of machine parts.(b) Storage and care of lubricants.(c) Lubricating equipment e.g. oil cans, grease guns, drip feed, etc.(d) Lubricating stations e.g. broach guides, etc.(e) Statistical control of lubrication e.g. schedule charts, etc.(f) Maintenance of automatic lubricating systems.(g) Recognition of faulty equipment e.g. leaking seals, etc.(h) Precaution re over lubrication e.g. motors, etc.(i) Precaution re replacing lost oil cup caps, dust plugs, etc.(j) Safety practices re power off while oiling machine.(k) Safety practices re good housekeeping e.g. oil on floor, etc.
2. Controlling the machine	<ul style="list-style-type: none">(a) Types, features and functions of primary controls e.g. power, clutch, etc.(b) Features and functions of broach pulling heads.(c) Principles of hydraulic controls.(d) precaution re reading manual and instruction cards.(e) Operating procedures.(f) Features and functions of automatic indexing mechanism controls.(g) Procedures in tilting the table.(h) Adjustments of work stops e.g. for depth of cut.(i) Safety practices re hands, gloves, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 1: THE MACHINE

OPERATIONS	KNOWLEDGE
3. Cleaning the machine	(a) Types and features of cleaning solvents and materials. (b) Cleaning schedules. (c) Critical locations e.g. broach guides. (d) Effects of cleaning solvents left on moving parts. (e) Precaution re use of air hose. (f) Safety practices re locking switch.
4. Adjusting the machine	(a) Methods of adjusting moving parts. (b) Methods of compensating for wear. (c) Responsibilities of the operator e.g. clean, adjust, lubricate, etc. (d) Procedures and equipment for checking the machine. (e) Fundamentals of moving parts. (f) Features, functions and adjustment of clutches. (g) Recognition and diagnosis of excess wear. (h) Methods of locating work stops, etc. (i) Procedures in mounting broaches. (j) Precaution re alignment of the broach. (k) Manufacturers literature for adjustments.

BLOCK XIII: BROACHING PRACTICE

UNIT 2: THE BROACH

OPERATIONS	KNOWLEDGE
1. Selecting a keyway broach	(a) Tooth design for various materials. (b) Pitch of the teeth. (c) Suitable materials for broaches. (d) The principles of broaching. (e) Methods of checking and testing keyway broaches. (f) Standards for keyways. (g) Reasons for offsetting the thread for attaching the broach puller. (h) Types of keyway broaches.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 2: THE BROACH

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (i) The maximum cutting load per tooth. (j) Chip control and disposal. (k) Life expectancy of a keyway broach. (l) Broach terminology. (m) The type of material to be cut e.g. ferrous, non-ferrous, etc. (n) Calculation of push or pull power needed. (o) Diagnosis and correction of broach damage e.g. chipped teeth. (p) Care and storage of broaches. (q) Recognition of worn and dull broaches. (r) Maximum sharpening allowable. (s) Methods of mounting. (t) Machine factors governing selection.
2. Selecting a broach for round holes	<ul style="list-style-type: none"> (a) Tooth design for various materials. (b) The use and design of chip breakers. (c) Materials suitable for broaches. (d) Calculations for stress on broach. (e) Reasons for staggered tooth pitch. (f) Calculation for chip space. (g) Broach nomenclature. (h) Allowances on the broach to compensate for shrinkage for various materials. (i) Factors governing the broach length. (j) Procedures for blind bores. (k) Adjustment of stroke for blind bores. (l) Precaution re correct sequence of broaches. (m) Methods of obtaining end clearance on blind bores.
3. Selecting a broach for splined holes	<ul style="list-style-type: none"> (a) Design for roughing and finishing broaches. (b) Tooth design for various materials. (c) Functions of each series of teeth e.g. truing, cutting, etc. (d) Fit tolerance on the splined guide e.g. on finished broach. (e) Principles of the broach cutting action. (f) Tooth form for cutting teeth. (g) Tooth form for sizing teeth. (h) Materials suitable for spline broaches.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 2: THE BROACH

OPERATIONS	KNOWLEDGE
3. Cont'd.	<ul style="list-style-type: none"> (i) Life expectancy for splined broaches. (j) Methods of mounting. (k) Methods of checking and testing splined broaches.

BLOCK XIII: BROACHING PRACTICE

UNIT 3: INTERNAL BROACHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Broaching an internal keyway	<ul style="list-style-type: none"> (a) Types and features of keyway broaches as B12, U2, O1, 5. (b) Methods of feeding a broach e.g. arbour press, broaching machine, etc. (c) Standards for keyways. (d) Types of keyways e.g. tapered, flat, etc. (e) Uses for keyways. (f) Types and features of spigots used when broaching keyways in parallel bores. (g) Materials suitable for shimming to deepen cut. (h) Design of shims. (i) Precaution re overloading first tooth of broach. (j) Types and features of spigots used in tapered bores. (k) Tolerance allowable. (l) Accuracy obtainable. (m) Types of surface finish obtainable on various materials. (n) Cutting speeds and feeds. (o) Precaution re stopping cut with carbide tipped broaches. (p) Measuring and testing equipment for keyways. (q) Layout techniques for broaching keyways. (r) Location of keyways e.g. under spoke on wheel. (s) Diagnosis and correction of broaching troubles. (t) Coolants and lubricants used for various materials.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 3: INTERNAL BROACHING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Cont'd.	<ul style="list-style-type: none"> (u) Application of coolants and lubricants. (v) Preparation of work for broaching. (w) Calculation of broaching time. (x) Precaution re vibration. (y) Limitations of broaches.
2. Broaching a round hole	<ul style="list-style-type: none"> (a) Types and features of round hole broaches as B12, U2, O2, 5. (b) Preparation of work e.g. drilling, boring, facing, etc. (c) Material to be broached. (d) Types and features of thrust bushings. (e) Allowances for material recovery. (f) Production methods. (g) Diagnosis and correction of round hole broaching troubles. (h) Reasons for broaching e.g. instead of reaming, etc. (i) Cutting speeds for various materials. (j) Chip handling and disposal. (k) Methods of shortening machining time and improving quality of work. (l) Principles of broaching. (m) Application of coolants and lubricants. (n) The use of hydraulic presses for broaching. (o) General class of work usually broached. (p) Methods of removing seized broaches.
3. Broaching a geometric hole, such as: a square a hexagon a triangular, etc.	<ul style="list-style-type: none"> (a) Types and features of geometric hole broaches. (b) Preparation of work for broaching e.g. drilling, etc. (c) Uses for geometric holes. (d) Calculations for geometric angles. (e) Maximum hole size for various geometric shapes. (f) Methods of lining up the broach to work. (g) Techniques for blind holes.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 3: INTERNAL BROACHING TECHNIQUES

OPERATIONS	KNOWLEDGE
4. Broaching a splined hole	<ul style="list-style-type: none"> (a) Types and features of spline broaches as B12, U2, O3, 5. (b) Uses for splined bores. (c) Features and functions of fixtures for maintaining alignment of splines and arms of components for vertical and horizontal machines. (d) Features and functions of multi-spline indexing fixtures. (e) Adjustments of outrigger supports for the broach. (f) Spline terminology. (g) Features and designs of fixtures for tapered hole splines. (h) Lubricants suitable for burnishing. (i) Precaution re cleanliness of broach and work piece.

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
1. Selecting the machine	<ul style="list-style-type: none"> (a) Types, uses and specifications of broach sharpening machines. (b) Grinding time with various machines. (c) Types of broach to be sharpened. (d) Methods of applying coolants. (e) Advantages of various makes of grinders.
2. Oiling the machine	<ul style="list-style-type: none"> (a) Features and functions of moving parts. (b) Types and features of oil cans and grease guns. (c) Types and features of oil and grease fittings. (d) Identification of lubricating equipment e.g. colour, code, tags, etc. (e) Precaution re cleaning points of application e.g. wipe oil cups, etc. (f) Kinds, uses and selection of lubricants.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
2. Cont'd.	<ul style="list-style-type: none"> (g) Methods of controlling oil flow e.g. sight oilers, wicks, etc. (h) Use of charts, etc., for statistical control. (i) Use of manufacturers' literature for selection of lubricants. (j) Precaution re mixing lubricants e.g. destroying blend, etc. (k) Safety practices re no-run cards for switches.
3. Controlling the machine	<ul style="list-style-type: none"> (a) Types, features and location of primary controls e.g. switches, clutch levers, etc. (b) Adjustments of machine before starting e.g. wheel guards, feeds, clearances, etc. (c) Types, features and adjustment of trips and table stops. (d) Adjustments for coolants. (e) Methods of setting feeds and speeds. (f) Safety practices re standing clear of wheel. (g) Safety practices re rags, loose clothing, etc.
4. Cleaning the machine	<ul style="list-style-type: none"> (a) Kinds of uses of cleaners and solvents. (b) Methods of removing grinding dust. (c) Cleaning techniques. (d) Recognition and diagnosis of excess wear. (e) Methods of removing corrosion. (f) Precaution re use of air hose. (g) Procedures in cleaning coolant sumps and filters. (h) Safety practices re use of explosive cleaners. (i) Precaution re use of caustic cleaners e.g. corrosion, spoilt paint, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
5. Selecting the abrasive wheel	<ul style="list-style-type: none"> (a) Type of material to be ground e.g. high speed steel, carbide, etc. (b) Type of machine the wheel is to be mounted on. (c) Use of charts and tables for wheel selection. (d) Speed of the grinder. (e) Condition of the grinder. (f) Amount of material removal. (g) Principles of grinding. (h) Types, features and functions of wheel bonds. (i) Interpretation of standard wheel markings. (j) Surface finish obtainable by various types of wheels. (k) Types and characteristics of wheels. (l) The grading of wheels. (m) Grinding wheel literature.
6. Mounting the abrasive wheel	<ul style="list-style-type: none"> (a) Design and features of grinder arbors and nuts. (b) Design and features of wheel flanges. (c) Relation of wheel size to flange size. (d) Precaution re loose inner flange. (e) Handling, care and storage of the wheels. (f) Tests for cracked wheels. Ring test (g) Bushing fit for the arbor. (h) Precaution re too tight a fit on arbor. (i) Methods of relieving the bore. (j) Precaution re hitting the wheel on guards, etc., when mounting. (k) Types and uses of wheel blotters. (l) Precaution re using warped wheels. (m) Pressure required for tightening wheel. (n) Types and application of all types of wheels e.g. mounted points, threaded hole wheels, etc.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
7. Truing the wheel	<ul style="list-style-type: none"> (a) Types, features and functions of wheel dressers e.g. diamond, ring, etc. (b) Reasons for truing the dressing. (c) Shape required for the wheel face. (d) Care and storage of wheel dressers. (e) Feeds and speeds for wheel dressing. (f) Recognition of glazed or loaded wheels. (g) Position and mounting techniques for wheel dressers. (h) Recognition of worn and chipped diamonds. (i) Types and features of holders for diamond dressers. (j) Methods of checking and testing wheel profiles. (k) Methods of crush dressing. (l) Dressing procedures.
8. Grinding a keyway broach	<ul style="list-style-type: none"> (a) Types, features and functions of keyway broaches. (b) Material the broach is made from. (c) Design for the chip space. (d) Amount of grinding on the finishing teeth. (e) Amount of grinding allowable. (f) Broach terminology e.g. back-off angle, land, face angle, etc. (g) Dial reading e.g. for pitch, depth, etc. (h) Methods of starting the cut. (i) Depth of cut and feeds allowable. (j) Grinding time allowable. (k) Measuring and inspection tools for broaches e.g. micrometers, face angle and radius gauges, etc. (l) Surface finish necessary. (m) Precaution re altering rise per tooth. (n) Precaution re burning. (o) Grinding procedures for keyway broaches. (p) Methods of grinding chip breakers. (q) Methods of how to reback off teeth with too large a land. (r) Types and features of mechanical chucks.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
9. Grinding a broach for round holes	<ul style="list-style-type: none"> (a) Types, features and functions of round hole broaches. (b) Wheel size for circular broaches. (c) Grinding time for small diameter wheels. (d) Size of wheel grain for roughing and finishing cuts. (e) Precaution re clean centres on broach before grinding. (f) Methods of checking centres for truth. (g) Methods of mounting circular broaches. (h) Reasons for selection of wet or dry grinding. (i) Types of coolants. (j) Application of coolants. (k) Precaution re letting wheel spin dry when leaving machine. (l) Recognition of dull or worn broaches. (m) Visual aids e.g. magnifying glass, lights, etc.
10. Grinding a splined broach	<ul style="list-style-type: none"> (a) Types, features and functions of splined broaches. (b) Methods of removing excessively worn teeth. (c) Precaution re grinding sides of teeth. (d) Material the broach is to cut e.g. steel, cast-iron, brass, etc. (e) Maximum width of land. (f) The use of intermediate supports to prevent sagging between centres and chatter. (g) Methods of setting and adjusting intermediate supports.
11. Grinding a surface broach	<ul style="list-style-type: none"> (a) Types, features and functions of surface broaches. (b) Methods of obtaining the face angle. (c) Top clearance angle. (d) Effect of abrupt breaks in the chip space on chip control. (e) Precaution re maintaining original tooth depth. (f) Methods of mounting surface broaches.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
11. Cont'd.	<ul style="list-style-type: none"> (g) Precaution re cleaning surfaces of mating parts. (h) Precaution re checking spindle bearings and wheel balance before grinding. (i) Calculation for the tooth step. (j) Wheel selection for backing off teeth on a surface broach. (k) Type of work the broach is to perform e.g. slab broaching, progressive broaching. (l) Diagnosis and correction of grinding troubles. (m) Maximum grinding heat allowable for various materials e.g. tungsten carbide, high speed steel, etc.
12. Grinding a helical broach	<ul style="list-style-type: none"> (a) Types, features and functions of helical broaches. (b) Tooth design. (c) Calculation for helix angles. (d) Methods of setting the wheel or table to correct angle. (e) Calibration reading. (f) Principles of vernier reading. (g) Calculations for vernier reading.
13. Grinding a geometric broach, such as:	<ul style="list-style-type: none"> (a) Types, features and functions of geometric broaches. (b) Design of cutting and finishing teeth. (c) Methods of indexing. (d) Fixtures for mounting. (e) Grinding procedures for geometric broaches. (f) Rakes and angles for various materials. (g) Methods of aligning the broach to the wheel. (h) Sections of the tooth getting the most wear.
a square	
a hexagon	
a triangle, etc.	

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIII: BROACHING PRACTICE

UNIT 4: BROACH GRINDING TECHNIQUES

OPERATIONS	KNOWLEDGE
14. Grinding a burnishing broach	(a) Types, features and functions of burnishing broaches. (b) Contour of burnishing rings. (c) Quality of finish necessary. (d) Methods of measuring surface finish. (e) Materials suitable for burnishing rings.

BLOCK XIV - BLUEPRINT READING AND SHOP SKETCHING

TABLE OF CONTENTS

	PAGE
Unit 1. Blueprint Reading.....	369
Unit 2. Orthographic Projection.....	374
Unit 3. Geometrical Drawing.....	379
Unit 4. Pictorial Drawing.....	381
Unit 5. Detail Working Drawings.....	383
Unit 6. Assembly Drawings.....	384
Unit 7. Duplicating Drawings.....	385

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 1: BLUEPRINT READING

OPERATIONS	KNOWLEDGE
1. Reading a 3-view drawing of an object by naming each of the three views	(a) Reasons for three views. (b) Features of top, front and side view.
2. Reading a 3-view working drawing of an object by naming all its component parts such as: (a) outlines (b) extension lines (c) dimension lines (d) dimensions	(a) Features and functions of outline extension lines, dimension lines, dimensions. (b) Reason for increment dimensioning.
3. Reading a 3-view working drawing of an object by naming each component part of a title block	(a) Features and functions of title blocks. (b) Methods of showing name of part, blueprint number, quantity required, order number, material, finish, date.
4. Reading a 3-view working drawing of a stepped object with visible edges	(a) Representation of edges on each of three views. (b) Method of locating dimensions. (c) Method of representing and reading fractional dimensions.
5. Reading a 3-view working drawing of a grooved object with invisible edges	(a) Representation of edges on each of three views. (b) Features of invisible edge line or hidden line.
6. Reading a working drawing of an object with angular grooves or edges such as: (a) vee block (b) dovetail as on lathe cross slide	(a) Representation of angles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 1: BLUEPRINT READING

OPERATIONS	KNOWLEDGE
7. Reading a scale working drawing of an object such as: (a) full size (b) half size (c) quarter size	(a) Method of reading and understanding drawings made to scale. (b) Reasons for making drawings to scale.
8. Reading a drawing of an object with (a) round corners (b) fillets (c) tee slots	(a) Methods of representing a reading drawing of an object with round corners, fillets and tee slots. (b) Features and functions of round corners, fillets and tee slots.
9. Reading a 2-view working drawing of a cylindrical object such as: shafts, collars, belts, studs, etc.	(a) Views required for cylindrical objects. (b) Features and functions of a center line. (c) Methods of representing diameter of cylindrical work.
10. Reading a 2-view working drawing of a cylindrical object showing a hidden edge by a hidden line	(a) Reasons for representing invisible circular surfaces or edges.
11. Reading a working drawing of an object that specifies fractional tolerances	(a) Interpretation of fractional tolerances, limits required. (b) How to read a drawing to find the upper and lower limit of tolerance. (c) Position of high and low tolerance.
12. Reading a working drawing of an object with decimal dimensions and decimal tolerances	(a) Representation of decimal dimension and tolerances. (b) Various methods of representing decimal tolerance. (c) How to read the tolerance, the high limit the low limit and the mean dimension.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 1: BLUEPRINT READING

OPERATIONS	KNOWLEDGE
13. Reading a working drawing of an object with holes in it such as: (a) reamed holes (b) bored holes	(a) Methods of dimensioning and representing notations relating to holes. (b) Features and functions of leader lines.
14. Reading a working drawing of an object with angular tolerances	(a) Representation of angular measurement to indicate tolerance. (b) How to read the angular tolerance, the high limit and the low limit.
15. Reading a one view working drawing of a cylindrical object	(a) Representation of an object by one view. (b) Reasons for a one view drawing. (c) Use of center line and abbreviation "D" for diameter and "R" for radius.
16. Reading a one view working drawing of a cylindrical object with necking or grooving	(a) Types of grooves used in necking. (b) Features and functions of necking. (c) Calculation of depth of necking groove for thread clearance. (d) Methods of representing necking on a working drawing.
17. Reading a one view working drawing of a cylindrical object with a chamfer	(a) Types of chamfers used for different purposes. (b) Reasons for chamfering a threaded part. (c) Methods of representing chamfers on a working drawing.
18. Reading a working drawing of a tapered turned or bevelled object	(a) Features and functions of tapered turned parts. (b) Methods of representing tapers or bevels. (c) Meaning of taper in inches per foot. (d) Taper notations. (e) Calculating tapers from given data.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 1: BLUEPRINT READING

OPERATIONS	KNOWLEDGE
19. Reading a working drawing of a flat tapered or bevelled object	(a) Features and functions of flat tapered parts. (b) Methods of representing flat tapered or bevelled parts. (c) Meaning of taper in inches per foot. (d) Taper notations. (e) Calculating tapers from given data.
20. Reading a working drawing of an object which shows types of finishes required	(a) Features and functions of various finish marks and notations.
21. Reading a working drawing of an object which is drawn in section	(a) Reasons for various types of sectioned drawings. (b) Features and functions of a cutting plane line. (c) Method of illustrating various materials by section lines.
22. Reading a working drawing of an object which has countersunk or counterbored holes in it	(a) Features and functions of countersunk and counterbored holes. (b) Notations for countersunk and counterbored holes. (c) Methods of finding diameter of holes.
23. Reading a working drawing of an object with external threads	(a) Conventional representation of external threads, right and left hand. (b) Methods of representing the various standard thread forms. (c) Interpretation of external thread notations. (d) Interpretation of thread notations with regard to classes of fits.
24. Reading a working drawing of bolts or screws with various types of heads	(a) Types, features and functions of various types of screw or bolt heads.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 1: BLUEPRINT READING

OPERATIONS	KNOWLEDGE
25. Reading a working drawing of an object with internal threads (right or left hand)	<ul style="list-style-type: none"> (a) Conventional representation of internal threads. (b) Methods of representing the various standard internal threads. (c) Interpretation of internal thread notations. (d) Interpretation of thread notations with regard to classes of fits.
26. Reading a working drawing of an object with blind drilled and tapped holes	<ul style="list-style-type: none"> (a) Methods of representing blind drilled and tapped holes. (b) Interpretation of notations for blind drilled and tapped holes.
27. Reading a working drawing of an object which is knurled	<ul style="list-style-type: none"> (a) Types, features and functions of knurled parts. (b) Conventional representation of various types of knurling. (c) Notations used on drawings for knurling.
28. Reading a working drawing of an object when changes have been made	<ul style="list-style-type: none"> (a) Methods of indicating changes in the drawing and title.
29. Reading a working drawing of an object having bosses or pads on it	<ul style="list-style-type: none"> (a) Types, features and functions of bosses and pads.
30. Reading a working drawing of an object with keyways in it	<ul style="list-style-type: none"> (a) Types, features and functions of various types of keyways. (b) Methods of representing keys and keyways.
31. Reading a working drawing with various types of fastenings in it	<ul style="list-style-type: none"> (a) Types, features and functions of various types of fastenings. (b) Method of representing fastenings on a working drawing. (c) Method of specifying and ordering various types of fastenings from a given working drawing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS	KNOWLEDGE
<p>1. Drawing an object of such form that it requires only one view</p> <p>e.g. irregular figures regular figures</p>	<p>(a) Advantages and disadvantages of freehand sketches.</p> <p>(b) Advantages and disadvantages of scale drawing.</p> <p>(c) Types and uses of emergency mechanical aids.</p> <p>(d) Types and features of drawing instruments and equipment.</p> <p>(e) Weight of line for outline of drawing.</p> <p>(f) Advantages and disadvantages of a one view drawing.</p> <p>(g) Freehand sketching techniques.</p> <p>(h) Emergency drawing techniques.</p> <p>(i) Scale drawing techniques.</p> <p>(j) Features and functions of a one view drawing.</p>
<p>2. Drawing an object such as a solid block of such form that it requires two views</p> <p>e.g. irregular regular</p>	<p>(a) Features and functions of a two view drawing.</p> <p>(b) Limitations of a two view drawing.</p> <p>(c) Orthographic drawing - 3rd angle projection.</p> <p>(d) Projection lines - features and functions.</p> <p>(e) Names of views.</p> <p>(f) Use of projection box.</p> <p>(g) Relative positions of views.</p> <p>(h) Representation of hidden edges.</p>
<p>3. Drawing an object such as solid block of such form that it requires to be drawn in three views</p> <p>e.g. irregular regular</p>	<p>(a) Features and functions of a three view drawing.</p> <p>(b) Advantages and disadvantages of a three view drawing.</p> <p>(c) Names of views.</p> <p>(d) Conventional intersections.</p> <p>(e) Need for auxiliary views.</p> <p>(f) Features and function of auxiliary views.</p> <p>(g) Use of projection box.</p> <p>(h) Relative position of views.</p>
<p>4. Drawing an object such as a solid block of such form that it requires to be drawn in four views.</p>	<p>(a) Features and function of four views.</p> <p>(b) Advantages and disadvantages of a four view drawing.</p> <p>(c) Names of views.</p> <p>(d) Relative position of views.</p>

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS	KNOWLEDGE
5. Drawing an object such as a solid block of such form that it requires to be drawn in five views.	(a) Features and function of five views. (b) Advantages and disadvantages of a five view drawing. (c) Names of views. (d) Relative position of views.
6. Drawing an object such as a solid block of such form that it requires to be drawn in six views	(a) Features and function of six views. (b) Advantages and disadvantages of a six view drawing. (c) Names of views. (d) Relative position of views.
7. Drawing an object such as a solid block with a through-hole such as: round elongated triangular rectangular square elliptical many sided tapered	(a) Methods of representing holes - plan and elevation. (b) Features and function of centre lines.
8. Drawing an object such as a solid block with grooves in it such as: plain flat grooves tee slot vee concave	(a) Methods of representing the intersection of grooves. (b) Features and functions of plain flat, tee slot, vee, concave grooves.
9. Drawing a solid object with holes in it such as: countersunk blind drilled counterbored undercut cored	(a) Features and functions of these holes. (b) Methods of representation.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS	KNOWLEDGE
10. Drawing a solid object with <ul style="list-style-type: none"> (a) chamfers (b) fillets (c) bevels (d) round corner (e) spotfaced boss 	<ul style="list-style-type: none"> (a) Features and functions of these varied forms. (b) Methods of representing these forms.
11. Drawing a part requiring a break such as: <ul style="list-style-type: none"> rods bars tubes structural forms extruded, rolled and cast forms 	<ul style="list-style-type: none"> (a) Conventional standard representation of breaks. (b) Need for breaks in drawing.
12. Drawing an object of wheel form such as: <ul style="list-style-type: none"> flat fabricated cast drop forged 	<ul style="list-style-type: none"> (a) Methods of representing bosses. (b) Methods of representing arms or spokes. (c) Methods of representing rims. (d) Features and function of wheel design. (e) Features and functions of inserted sections. (f) Features and functions of fillets. (g) Features and functions of round corners. (h) Use of fillet finders. (i) Design of forgings. (j) Design of castings. (k) Conventional violations of projection.
13. Drawing an object of arm form such as: <ul style="list-style-type: none"> rockers brackets levers 	<ul style="list-style-type: none"> (a) Need for revolved sections. (b) Features and function of broken view and revolved section.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS

KNOWLEDGE

14. Drawing a part requiring sectional views.

- (a) Need for a sectional view.
- (b) Features and function of various sectional views, such as:

- half section
- full section
- inserted section
- offset section
- revolved section
- removed section
- broken out section
- code for materials in section

15. Drawing an external threaded part such as:

N.C.
acme
square
buttress
rolled
multiple

- (a) Conventional representation of standard external threads.
- (b) Features and functions of basic threads.
- (c) Representation of threads in section.
- (d) Methods of providing thread clearance and thread end protection. e.g. convex or chamfered ends.

16. Drawing an internal threaded part such as:

N.C.
acme
square
buttress
rolled
multiple

- (a) Conventional representation of standard internal threads.
- (b) Representation of threads in section.

17. Drawing an object of ribbed construction such as:

bracket
rocker arm
hangers
cranks

- (a) Need for removed section and revolved sections.
- (b) Features and functions of various forms.
- (c) Conventional violation of projection.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS	KNOWLEDGE
18. Drawing an object to show an intersection e.g. flat to flat cylinder to cylinder cylinder to flat	(a) Methods of representing an intersection.
19. Drawing an object (a) by true projection (b) by rotated method of projection	(a) Examples of violation of true projection. (b) Examples of preferred method and true projection.
20. Drawing gear forms such as: spur, rack, bevel helical, worm.	(a) Features and function of gears. (b) Construction detail form of gears. (c) Conventional representation.
21. Drawing cams and motions such as: plate cam face cam constant diameter cam curved flank cam flat follower tangential cam roller follower inverse cam rectilinear motion cam yoke type follower for positive motion cam. wiper cam drum or barrel cam	(a) Features and functions of cams. (b) Construction detail form of cams. (c) Conventional representation.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 2: ORTHOGRAPHIC PROJECTION

OPERATIONS	KNOWLEDGE
22. Drawing couplings such as: plain flexible	(a) Features and functions of couplings. (b) Construction details of couplings. (c) Conventional representation.
23. Drawing a jig	(a) Features and functions of a jig.
24. Drawing a fixture	(a) Features and functions of a fixture.
25. Drawing a part from a given work description	(a) Structural visualization. (b) Conventional symbols and representation.
26. Drawing springs such as: compression tension torsion	(a) Features and function of springs. (b) Conventional representation.

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 3: GEOMETRICAL DRAWING

OPERATIONS	KNOWLEDGE
1. Dividing a straight line into any number of equal parts	(a) Use of drafting instruments. (b) Methods of dividing lines into equal parts. (c) Strip title.
2. Drawing a line parallel to another line	(a) Methods of drawing one line parallel to another.
3. Erecting perpendiculars	(a) Methods of erecting perpendiculars.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 3: GEOMETRICAL DRAWING

OPERATIONS	KNOWLEDGE
4. Constructing an angle equal to a given angle	(a) Parts of an angle. (b) Kinds of angles. (c) Methods of constructing angles.
5. Dividing an angle into a number of equal parts	(a) Limitations of number of equal divisions. (b) Methods of dividing an angle into a number of equal parts.
6. Constructing a triangle	(a) Parts of a triangle. (b) Kinds of triangles. (c) Methods of constructing triangles.
7. Constructing a quadrilateral	(a) Kinds of quadrilaterals. (b) Methods of constructing quadrilaterals.
8. Constructing a polygon	(a) Kinds of polygons. (b) Methods of constructing polygons.
9. Constructing a circle or arc	(a) Parts of a circle. (b) Relationship of radius, diameter and circumference. (c) Methods of constructing circles and arcs.
10. Dividing a circle or arc into any number of equal parts	(a) Limitations of the number of equal divisions.
11. Locating the center of a circle or arc	(a) Methods of locating the center of a circle or arc.
12. Drawing a circle through three given points	(a) Bisection of chords.
13. Drawing a tangent to a circle or arc	(a) Definition of tangent. (b) Methods of drawing tangents to circles and arcs.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 3: GEOMETRICAL DRAWING

OPERATIONS	KNOWLEDGE
14. Drawing a circle or arc tangent to a straight line or other circles or arcs	(a) Methods of drawing circles and arcs tangent to straight lines or other circles.
15. Laying off on a straight line the approximate length of a circle or arc	(a) Methods of laying off approximate lengths of a circle and arc.
16. Laying off on a given circle or arc the approximate length of a straight line	(a) Methods of laying off approximate lengths of a straight line on a given circle and arc.
17. Constructing an ellipse	(a) Conic sections. (b) Methods of constructing ellipses.
18. Developing a cylinder	(a) Parts of a cylinder. (b) Kinds of cylinders. (c) Parallel line development.
19. Developing a cone	(a) Parts of a cone. (b) Kinds of cones. (c) Radial line development.

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 4: PICTORIAL DRAWING

OPERATIONS	KNOWLEDGE
1. Making an isometric drawing containing isometric straight lines	(a) Advantages and disadvantages of isometric drawing. (b) Relationship between isometric projection and isometric drawing. (c) Isometric scale. (d) Isometric axes.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 4: PICTORIAL DRAWING

OPERATIONS	KNOWLEDGE
1. Cont'd.	(e) Isometric planes. (f) Isometric lines. (g) Titles.
2. Making an isometric drawing containing non-isometric straight lines	(a) Non-isometric straight lines. (b) Methods of drawing non-isometric straight lines.
3. Making an isometric drawing of an object containing curved lines	(a) Methods of drawing circles and arcs in isometric. (b) Methods of drawing curves in isometric.
4. Making an isometric drawing in section	(a) Methods of drawing isometric sections.
5. Making an oblique drawing of an object containing straight lines only	(a) Advantages and disadvantages of oblique drawing. (b) Cavalier and cabinet drawing. (c) Oblique axes. (d) Rules for oblique drawing.
6. Making an oblique drawing of an object containing curved lines	(a) Methods of drawing oblique curves.
7. Making an exploded drawing or sketch of an object with component parts	(a) Need of exploded drawings. (b) Isometric drawing. (c) Isometric sections.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND
SHOP SKETCHING

UNIT 5: DETAIL WORKING DRAWINGS
AND SKETCHES

OPERATIONS	KNOWLEDGE
1. Making a detail working drawing or sketch of a simple object containing straight lines only	<ul style="list-style-type: none"> (a) Scale drawing. (b) Sketching. (c) Orthographic projection. (d) Isometric drawing. (e) Oblique drawing. (f) Extension lines. (g) Dimension lines. (h) Arrowheads. (i) Dimension figures. (j) Leaders. (k) General notations. (l) Specific notations. (m) Finish marks. (n) Reading direction for figures. (o) Systems of writing dimension values. (p) Size dimensions. (q) Location dimensions. (r) Selection of dimensions. (s) Correlation of dimensions. (t) Superfluous dimensions. (u) Placement of dimensions. (v) Dimensioning in limited space. (w) The order of dimensioning. (x) Block title. (y) Strip title. (z) Part circles.
2. Making a detail working drawing or sketch of an object containing holes	<ul style="list-style-type: none"> (a) Dimensions and specifications of holes. (b) Location of holes.
3. Making a detail working sketch of an object containing arcs and curves	<ul style="list-style-type: none"> (a) Methods of dimensioning arcs and curves.
4. Making a detail working drawing or sketch of an object containing angles	<ul style="list-style-type: none"> (a) Methods of dimensioning angles.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 5: DETAIL WORKING DRAWINGS AND SKETCHES

OPERATIONS	KNOWLEDGE
5. Making a detail working drawing or sketch of an object containing chamfers	(a) Methods of dimensioning chamfers.
6. Making a detail working drawing or sketch of an object containing a taper	(a) Kinds of tapers. (b) Methods of dimensioning tapers.
7. Making a detail working drawing or sketch of an object requiring precision dimensions	(a) Manufacturing process. (b) Basic size. (c) Tolerance. (d) Allowance. (e) Maximum limit. (f) Minimum limit. (g) Kinds of fits. (h) Methods of dimensioning with tolerance.

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 6: ASSEMBLY DRAWING AND SKETCHING

OPERATIONS	KNOWLEDGE
1. Making an assembly drawing or sketch of an object with component parts	(a) Need for assembly drawings. (b) Sub-assembly drawings. (c) Orthographic drawing. (d) Limiting of hidden detail. (e) Dimensions on assembly drawings. (f) Sections on assembly drawings. (g) Violations of projection on assembly drawings. (h) Part circles. (i) Titles.
2. Making a pictorial assembly drawing or sketch of an object with component parts	(a) Need for pictorial assembly drawings. (b) Isometric drawing.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XIV: BLUEPRINT READING AND SHOP SKETCHING

UNIT 7: DUPLICATING DRAWINGS

OPERATIONS

KNOWLEDGE

1. Making duplications of a drawing by means of carbon papers
 - (a) Features and functions of carbon papers.
 - (b) Methods of duplicating with carbon paper.
2. Making duplications of a drawing by hectographing
 - (a) Methods of preparing original hectograph copy.
 - (b) Methods of duplicating with hectograph copy.
3. Making duplications of a drawing by ditto-graphing
 - (a) Features and functions of dittograph machines.
 - (b) Methods of preparing original dittograph copy.
 - (c) Methods of duplicating with dittograph copy.
4. Making duplications of a drawing by means of sensitized papers:
 - (a) blueprints
 - (b) white prints
 - (c) ozalid prints
 - (a) Features and functions of sensitized papers.
 - (b) Features and functions of machines for duplicating with sensitized paper.
 - (c) Methods of duplicating with sensitized paper.
 - (d) Safety precautions re use of potassium bichromate when blueprinting.
5. Making duplications of a drawing by mimeographing
 - (a) Features and functions of mimeograph machines.
 - (b) Features and functions of stencils.
 - (c) Methods of preparing a stencil.
 - (d) Methods of duplicating with stencils.

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(A): PRACTICAL SHOP MATHEMATICS (FUNDAMENTAL)

TABLE OF CONTENTS

	PAGE
PART ONE: FUNDAMENTALS OF BASIC MATHEMATICS	
Units 1- 5: Whole Numbers.....	387
Units 6-11: Common Fractions.....	387
Units 12-17: Decimal Fractions.....	387
Units 18-24: Measurement.....	387
Units 25-28: Percentage and Averages.....	388
Units 29-32: Finance.....	388
Units 33-36: Graphs and Statistics.....	388
PART TWO: FUNDAMENTALS OF APPLIED ALGEBRA	
Units 37-42: Symbols.....	388
Units 43-50: Equations.....	388
Units 51-54: Ratio and Proportion.....	389
Units 55-58: Exponents.....	389
Units 59-62: Radicals.....	389
Units 63-67: Formulas.....	389
PART THREE: FUNDAMENTALS OF APPLIED GEOMETRY	
Units 68-72: Geometric Lines and Shapes.....	389
Units 73-75: Common Geometric Constructions....	390
PART FOUR: FUNDAMENTALS OF APPLIED TRIGONOMETRY	
Units 76-80: Triangles.....	390

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(A): PRACTICAL SHOP MATHEMATICS (FUNDAMENTAL)

PART ONE: Fundamentals of Basic Mathematics

Section I - WHOLE NUMBERS

- Unit 1 Addition of Whole Numbers
- 2 Subtraction of Whole Numbers
- 3 Multiplication of Whole Numbers
- 4 Division of Whole Numbers
- 5 Achievement Test on Whole Numbers

Section II - COMMON FRACTIONS

- Unit 6 The Concept of Common Fractions
- 7 Addition of Fractions
- 8 Subtraction of Fractions
- 9 Multiplication of Fractions
- 10 Division of Fractions
- 11 Achievement Test on Common Fractions

Section III - DECIMAL FRACTIONS

- Unit 12 The Concept of Decimal Fractions
- 13 Addition of Decimals
- 14 Subtraction of Decimals
- 15 Multiplication of Decimals
- 16 Division of Decimals
- 17 Achievement Test on Decimals

Section IV - MEASUREMENT (Direct and Computed)

- Unit 18 Standardization of Units of Measure
- 19 Principles of Linear Measure
- 20 Principles of Angular and Circular Measure
- 21 Principles of Surface Measure
- 22 Principles of Volume Measure
- 23 The Metric System of Measurement
- 24 Achievement Test on Measurement

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(A): PRACTICAL SHOP MATHEMATICS (FUNDAMENTAL)

• Section V - PERCENTAGE AND AVERAGES

- Unit 25 The Concept of Per Cent and Percentage
- 26 Application of Percentage, Base and Rate
- 27 Averages and Estimates
- 28 Achievement Test on Percentage and Averages

Section VI - FINANCE

- Unit 29 Money and Time Calculations
- 30 Manufacturing Costs and Discounts
- 31 Pay Rolls and Taxes
- 32 Achievement Test on Finance

Section VII - GRAPHS AND STATISTICS

- Unit 33 Development and Interpretation of Bar Graphs
- 34 Development and Interpretation of Line Graphs
- 35 Development and Application of Circle Graphs
- 36 Achievement Test on Graphs and Statistics

PART TWO: Fundamentals of Applied Algebra

Section VIII - SYMBOLS

- Unit 37 The Concept of Symbols
- 38 Application of Symbols in Addition
- 39 Application of Symbols in Subtraction
- 40 Application of Symbols in Multiplication
- 41 Application of Symbols in Division
- 42 Achievement Test on Symbols

Section IX - EQUATIONS

- Unit 43 A Concept of Equations
- 44 Positive and Negative Quantities
- 45 Solving Equations by Addition
- 46 Solving Equations by Subtraction
- 47 Solving Equations by Multiplication
- 48 Solving Equations by Division
- 49 Solving Practical Problems with Equations
- 50 Achievement Test on Equations

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(A): PRACTICAL SHOP MATHEMATICS (FUNDAMENTAL)

Section X - RATIO AND PROPORTION

- Unit 51 The Concept of Ratio
- 52 The Concept of Proportion
- 53 Application of Relationships to Proportion
- 54 Achievement Test on Ratio, Proportion and Relationships

Section XI - EXPONENTS

- Unit 55 The Concept of Exponents
- 56 Algebraic Multiplication of Numbers and Letters
- 57 Algebraic Division
- 58 Achievement Test on Exponents

Section XII - RADICALS

- Unit 59 Square Root of Whole Numbers
- 60 Square Root of Fractions and Algebraic Numbers
- 61 Application of Square Root Tables
- 62 Achievement Test on Radicals

Section XIII - FORMULAS

- Unit 63 The Concept and Use of Formulas
- 64 Application of Formulas to Squares, Rectangles and Regular Solids
- 65 Application of Formulas to Circles and Parts of Circles
- 66 Application of Special Formulas and Handbook Data
- 67 Achievement Test on Formulas and Handbook Data

PART THREE: Fundamentals of Applied Geometry

Section XIV - GEOMETRIC LINES AND SHAPES

- Unit 68 The Concept of Lines, Angles and Circles
- 69 Basic Flat Shapes
- 70 Basic Solid Shapes
- 71 Congruent and Symmetrical Flat and Solid Shapes
- 72 Achievement Test on Geometric Lines and Shapes

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(A): PRACTICAL SHOP MATHEMATICS (FUNDAMENTAL)

Section XV - COMMON GEOMETRIC CONSTRUCTIONS

- Unit 73 Basic Geometric Constructions
- 74 Constructions Qpplied to Geometric Shapes
- 75 Achievement Test on Geometric Constructions

PART FOUR: Fundamentals of Applied Trigonometry

Section XVI - TRIANGLES

- Unit 76 The Concept of Right Angle Triangle Trigonometry
- 77 Application of Tables of Trigonometric Functions
- 78 Acute Angle Triangles
- 79 Oblique Angle Triangles
- 80 Achievement Test on Applied Trigonometry

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(B) - PRACTICAL SHOP MATHEMATICS (PROBLEMS)

TABLE OF CONTENTS

	PAGE
Units 1- 4 - Whole Numbers	392
Units 5- 9 - Fractions	392
Units 10- 14 - Decimals	392
Units 15- 19 - Percentage	392
Units 20- 25 - Weights and Measures	392
Units 26- 29 - Powers and Roots	393
Units 30- 36 - Ratio and Proportion	393
Units 37- 58 - Practical Measurements	393
Units 59- 66 - Formulas	394
Units 67- 68 - Geometrical Constructions	394
Units 69- 70 - Graphs	394
Units 71- 82 - Trigonometry	394
Units 83- 86 - Oblique Triangles	394
Units 87- 91 - Belt Drives and Gear Trains	395
Unit 92 - Gear Computations	395
Units 93- 97 - Lathe Work	395
Units 98-100 - Milling Machine	395
Units 101-103 - Planer & Shaper	395
Units 104-106 - Advanced Shop Problems	395

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(B): PRACTICAL SHOP MATHEMATICS (PROBLEMS)

SHOP PROBLEMS

Section I - WHOLE NUMBERS

- Unit 1 Addition of Whole Numbers
- 2 Subtraction of Whole Numbers
- 3 Multiplication of Whole Numbers
- 4 Division of Whole Numbers

Section II - FRACTIONS

- Unit 5 Addition of Fractions
- 6 Subtraction of Fractions
- 7 Multiplication of Fractions
- 8 Division of Fractions
- 9 Miscellaneous Fractions

Section III - DECIMALS

- Unit 10 Addition of Decimals
- 11 Subtraction of Decimals
- 12 Multiplication of Decimals
- 13 Division of Decimals
- 14 Miscellaneous Decimals

Section IV - PERCENTAGE

- Unit 15 Percentage
- 16 Discounts
- 17 Interest
- 18 Taxes and Per Cent Error
- 19 Averages

Section V - WEIGHTS AND MEASURES

- Unit 20 Linear Measure
- 21 Liquid Measure
- 22 Horsepower
- 23 Metric System
- 24 Metric Equivalents
- 25 Angular Measure

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(B): PRACTICAL SHOP MATHEMATICS (PROBLEMS)

Section VI - POWERS AND ROOTS

- Unit 26 Powers and Roots
- 27 Square Root
- 28 Review of Powers and Roots
- 29 Triangles

Section VII - RATIO AND PROPORTION

- Unit 30 Ratio and Proportion
- 31 Similar Triangles
- 32 Miscellaneous Problems
- 33 Gear Ratios
- 34 Pulley Speeds
- 35 Miscellaneous Problems
- 36 Belt Widths

Section VIII - PRACTICAL MEASUREMENTS

- Unit 37 Areas of Rectangles
- 38 Areas of Parallelograms
- 39 Angles
- 40 Areas of Triangles
- 41 Right Triangles - Hexagons
- 42 Triangles - Threads
- 43 Areas of Trapezoids
- 44 Review Problems
- 45 Circles
- 46 Circles, Segments, Sectors, Ellipses
- 47 Circles - Practical Problems
- 48 Rectangular Solids
- 49 Cylinders
- 50 Review Problems - Solids
- 51 Pyramids
- 52 Cones
- 53 Spheres
- 54 Circular Rings
- 55 Frustums
- 56 Measuring Irregular Forms
- 57 Geometrical Forms
- 58 Review Problems in Measurement

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(B): PRACTICAL SHOP MATHEMATICS (PROBLEMS)

Section IX - FORMULAS

- Unit 59 Positive and Negative Quantities
- 60 Equations
- 61 Horsepower
- 62 Screw Head Dimensions
- 63 Horsepower and Tap Drill Formulas
- 64 Taper Pin and Gear Formulas
- 65 Review Problems
- 66 Geometrical Equations

Section X - GEOMETRICAL CONSTRUCTION

- Unit 67 Fundamental Constructions
- 68 Shop Problems

Section XI - GRAPHS

- Unit 69 Practical Applications of Graphs and Charts
- 70 Plotting Equations

Section XII(A) - TRIGONOMETRY

- Unit 71 Natural Functions
- 72 Typical Trigonometric Solutions
- 73 Tapers and Wedges
- 74 Helix Angles
- 75 Measuring Dovetails
- 76 Measuring Threads
- 77 Measuring Angle Cuts
- 78 Measuring Acme Threads
- 79 Measuring Angles with Sine Bar
- 80 Measuring Angles (Disk Method)
- 81 Miscellaneous Problems
- 82 Logarithms

Section XII(B) - OBLIQUE TRIANGLES

- Unit 83 Functions of Angles
- 84 Laws of Sines and Cosines
- 85 Practical Problems
- 86 Oblique Triangles

AN ANALYSIS OF THE MACHINIST'S TRADE

BLOCK XV(B): PRACTICAL SHOP MATHEMATICS (PROBLEMS)

Section XIII - BELT DRIVES AND GEAR TRAINS

- Unit 87 Pulley Speeds
- 88 Lathe Speeds
- 89 Gear Speed and Direction
- 90 Change Gear Drives
- 91 Power of Belting

Section XIV - GEAR COMPUTATIONS

- Unit 92 Practical Problems

Section XV - LATHE WORK

- Unit 93 Cutting Speeds
- 94 Tapers
- 95 Screw Threads
- 96 Drilling
- 97 Practical Problems

Section XVI - MILLING MACHINE

- Unit 98 Cutter Speeds
- 99 Indexing
- 100 Practical Problems

Section XVII - PLANER & SHAPER

- Unit 101 Planer Speeds
- 102 Net Cutting Speeds
- 103 Practical Problems

Section XVIII - ADVANCED SHOP PROBLEMS

- Unit 104 Drawing Shells
- 105 Practical Problems
- 106 Practical Problems

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1950